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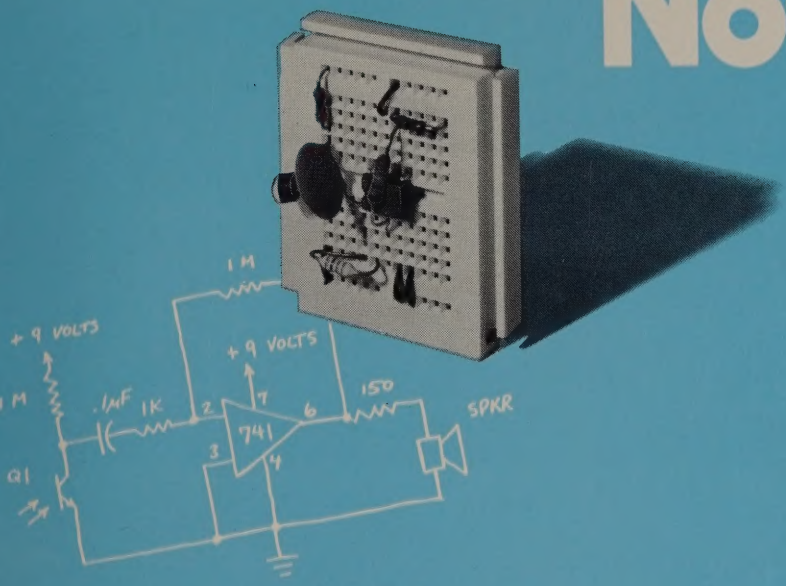
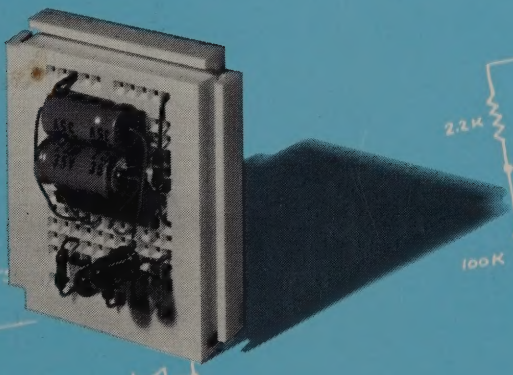
1980 EDITION

Engineer's Notebook

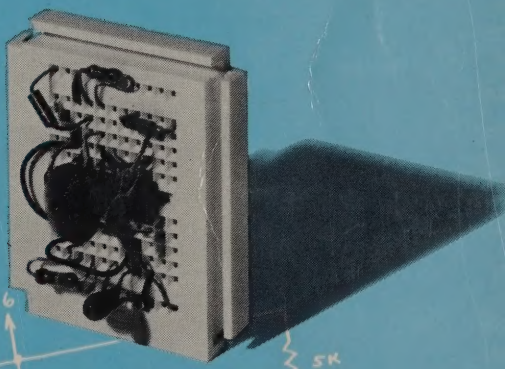
INTEGRATED CIRCUIT APPLICATIONS



PHOTOTRANSISTOR LIGHT RECEIVER



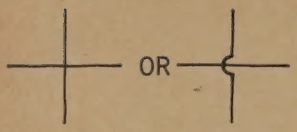
DUAL LED FLASHER



TRI-STATE TONE SOURCE

1 — (TWO-TONE)
2 — (STEADY)
3 — (TONE BURST)

COMMON SCHEMATIC SYMBOLS



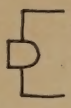
UNCONNECTED WIRES

CONNECTED WIRES

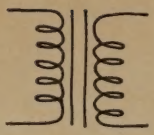
GROUND

METER

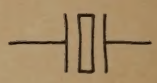
SPEAKER



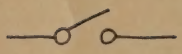
MICROPHONE



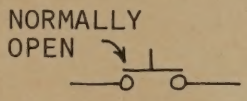
TRANSFORMER



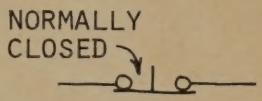
CRYSTAL



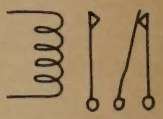
SPST TOGGLE SWITCH



PUSHBUTTON SWITCH

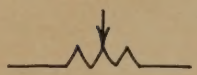


PUSHBUTTON SWITCH

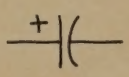


RELAY

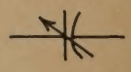
RESISTOR



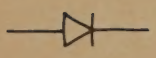
POTENTIOMETER



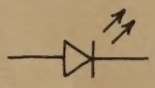
CAPACITOR



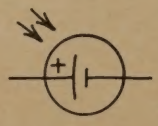
VARIABLE CAPACITOR



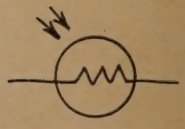
DIODE



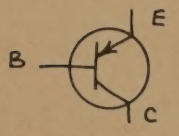
LIGHT EMITTING DIODE (LED)



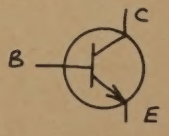
SOLAR CELL



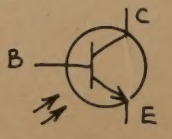
PHOTORESISTOR



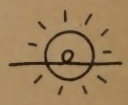
PNP TRANSISTOR



NPN TRANSISTOR



PHOTOTRANSISTOR (NPN)



LAMP

ENGINEER'S NOTEBOOK

A HANDBOOK OF INTEGRATED CIRCUIT APPLICATIONS

BY

FORREST M. MIMS, III

CONTRIBUTING EDITOR
POPULAR ELECTRONICS

FIRST EDITION

SECOND PRINTING--1980

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Due to the large volume of mail received by Radio Shack and the author, it is impossible to answer letters requesting custom circuit designs, technical advice, troubleshooting assistance, etc. But though we cannot acknowledge individual letters, we will nevertheless be delighted to review carefully your comments, impressions and suggestions about this book. Address your comments to:

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Thanks in advance to those who write. And special thanks to Robert Pease, Michael L. Ardai, George W. Jehle, B.J. "Stan" Staneslow, Chris Rogers and Desmaret Henri for finding and informing us about a number of errors (all of them minor) in the first printing of this book.

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INTRODUCTION

Though I've kept engineering notebooks for 15 years, the idea for this notebook came from Gary Burkhart, Radio Shack's parts buyer, and Dave Gunzel, manager of Radio Shack's publications division. Gary has long wanted to include in his parts line a no-frills sourcebook of circuits for every Radio Shack IC. He and Dave have invested many hours answering my questions, providing components and technical information and reviewing the circuits. I'm grateful for their assistance.

Unless otherwise acknowledged, the circuits in this notebook are adapted from these sources:

1. Applications information published by the manufacturers of the various ICs.

2. My engineering notebooks.

3. "Experimenter's Corner" and "Project of the Month," two columns I write each month for POPULAR ELECTRONICS magazine.

Many of the circuits were developed specifically for this notebook. I hope you enjoy working with them as much as I have!

Forest M. Mims, III

HOW TO USE THIS BOOK

To squeeze the maximum number of circuits into this notebook, only essential information is provided. Therefore you will want to use this notebook in conjunction with Radio Shack's "Semiconductor Reference Handbook" and other data books.

For a quickie review of important components and construction tips, read the next few pages. The remainder of the notebook is divided into two major sections: digital and linear. The digital section is further divided into two major IC families: MOS/CMOS and TTL/LS. The chips in each section are organized according to function, not numerical sequence.

Though most circuits in this book can function on their own, consider them as building blocks you can connect to other circuits to accomplish new applications. Experiment! Change resistors and capacitors in RC circuits to alter frequencies and timing. Add new functions. Above all, work with as many different chips as you can. If you've always used TTL, you'll be impressed with the operating flexibility of CMOS. If your forte is digital logic, you'll be amazed at what you can do with an op-amp. Finally, keep a record of your experiments and circuit designs. A notebook with a grid ruling like this one is best, but a 50¢ spiral notebook is OK.

For beginners only....Be sure to read the next few pages! Begin with simple chips (gate packages, timers, op-amps, etc.), and you'll soon be ready for more advanced circuits and projects. Good luck!

REVIEWING THE BASICS

INTRODUCTION

"Can I use a 0.22 uF capacitor instead of a 0.10 uF unit?"

"Is it OK to substitute a 12,000 ohm resistor for a 10,000 ohm unit?"

This section will tackle these common questions and many others. Master them, and you will be well prepared to tackle the circuits in this book!

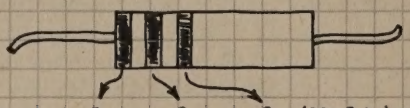
RESISTORS

Resistors limit the flow of electrical current. A resistor has a resistance (R) of 1 ohm if a current (I) of 1 ampere flows through it when a potential difference (E) of 1 volt is placed across it. In other words:

$$R = \frac{E}{I} \text{ (or) } I = \frac{E}{R} \text{ (or) } E = IR$$

These handy formulas form Ohm's law. Memorize them! You'll use them often.

Resistors are identified by a color code:



COLOR	1	2	3 (Multiplier)
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	(none)

A fourth color band may be present. It specifies the tolerance of the resistor. Gold is ± 5% and silver is ± 10%. No fourth band means ± 20%.

Since no resistor has a perfect tolerance, it's often OK to substitute resistors. For example, it's almost always OK to use a 1.8K resistor in place of a 2.0K unit. Just try to stay within 10-20% of the specified value.

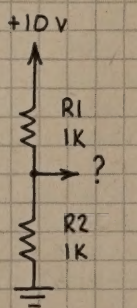
What does K mean? It's short for 1,000. 20K means 20 x 1,000 or 20,000 ohms. M is short for megohm or 1,000,000 ohms. Therefore a 2.2M resistor has a resistance of 2,200,000 ohms.

Resistors which resist lots of current must be able to dissipate the heat that's produced. Always use resistors with the specified power rating! No power rating specified? Then it's usually OK to use 1/4 or 1/2 watt units.

Almost every electronic circuit uses resistors. Here are three of the most important applications for resistors:

1. Limit current to LEDs, transistors, speakers, etc.

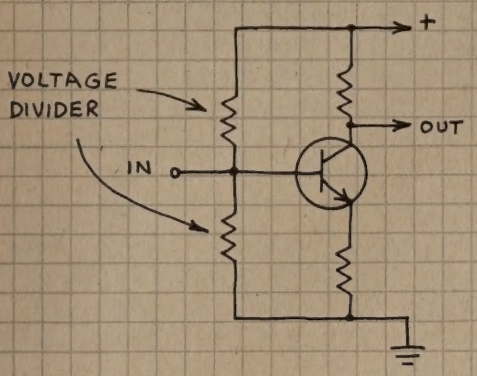
2. Voltage division. For instance:



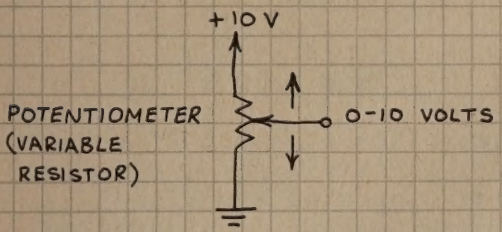
The voltage at ? is I x R2. I means the current through R1 and R2. So I = 10/(R1 + R2) or 0.005 amperes. Therefore, ? = (0.005) x (1000) or 5 volts.

Note that the total resistance of R1 and R2 is simply R1 + R2. This rule provides a handy trick for making custom resistances.

Voltage dividers are used to bias transistors:



They're also a convenient source of variable voltage:



And they're useful in voltage sensing circuits. See the comparator circuits in this notebook.

3. They control the charging time of capacitors. Read on...

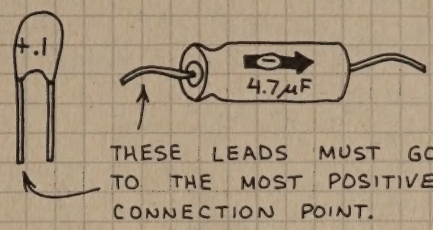
CAPACITORS

Capacitors store electrical energy and block the flow of direct current while passing alternating current. Capacitance is specified in farads. One farad represents a huge capacitance so most capacitors have values of small fractions of a farad:

1 microfarad (uF)= 10^{-6} farad
1 picofarad (pF)= 10^{-12} farad
or
1 uF = 1,000,000 pF

The value of a capacitor is usually printed on the component. The uF and pF designations may not be present. Small ones marked 1-1000 are rated in pF; larger ones marked .001-1000 are rated in uF.

Electrolytic capacitors provide high capacity in a small space. Their leads are polarized and must be connected into a circuit in the proper direction.



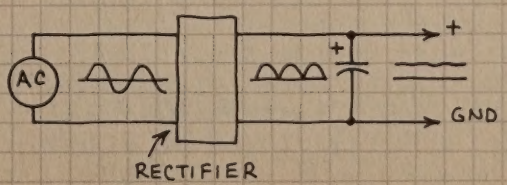
Capacitors have a voltage rating. It's usually printed under the capacity marking. The voltage rating must be higher than the highest expected voltage (usually the power supply voltage).

Caution: A capacitor can store a charge for a considerable time after power is removed. This charge can be dangerous! A large electrolytic capacitor charged to only 5 or 10 volts can melt the tip of a screwdriver placed across its leads! High voltage capacitors can store a lethal charge! Discharge a capacitor by carefully placing a resistor (1K or more; use Ohm's law) across its leads. Use only one hand to prevent touching both leads of the capacitor.

Important capacitor applications:

1. Remove power supply spikes. (Place 0.01-0.1 uF across power supply pins of digital ICs. Stops false triggering.)

2. Smooth rectified AC voltage into steady DC voltage. (Place 100-10,000 uF across rectifier output.)

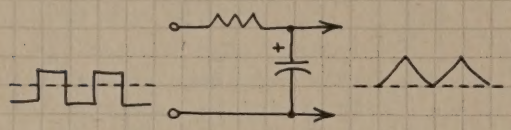


3. Block DC signal while passing AC signal.

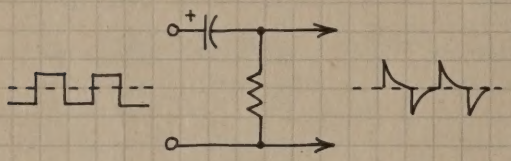
4. Bypass AC signal around a circuit or to ground.

5. Filter out unwanted portions of a fluctuating signal.

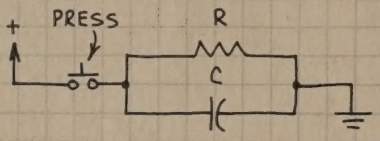
6. Use with resistor to integrate a fluctuating signal:



7. Or to differentiate a fluctuating signal:



8. Perform a timing function:



C will quickly charge...then slowly discharge through R.

9. Store a charge to keep a transistor turned off or on.

10. Store a charge to be dumped through a flashtube or LED in a fast and powerful pulse.

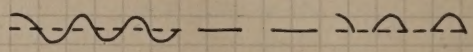
Can you substitute capacitors? In most cases changing the value of a capacitor 10% or even 100% will not cause a malfunction, but circuit operation may be affected. In a timing circuit, for example, increasing the value of the timing capacitor will increase the timing period. Changing the capacitors in a filter will change the filter's frequency response. Be sure to use the proper voltage rating. And don't worry about the difference between 0.47 and 0.5 uF.

SEMICONDUCTORS

Usually made from silicon. Be sure to observe all operating restrictions. Brief descriptions of important semiconductor devices:

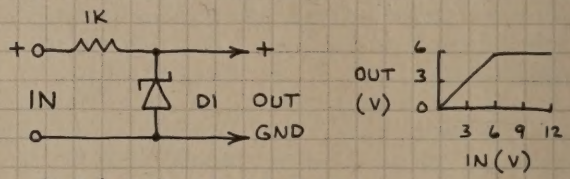
DIODES

Permit current to flow in but one direction (forward bias). Used to rectify AC, allow current to flow into a circuit but block its return, etc.



ZENER DIODES

The zener diode is a voltage regulator. In this typical circuit, voltage exceeding the diode's breakdown voltage is shunted to ground:

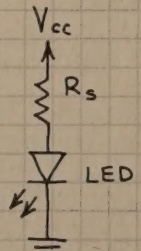


D1 = 6 VOLT ZENER DIODE

Zeners can also protect voltage sensitive components and provide a convenient reference voltage.

LIGHT EMITTING DIODES

LEDs emit green, yellow, red or infrared when forward biased. A series resistor should be used to limit current to less than the maximum allowed:



$$R_S = \frac{V_{CC} - V_{LED}}{LED_I}$$

Example: V_{LED} of red LED is 1.7 volts. For a forward current (LED_I) of 20 mA at V_{CC} = 5 volts, R = 330 ohms. Don't exceed LED_I!!

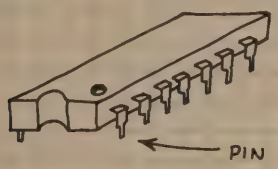
Infrared LEDs are much more powerful than visible LEDs, but their radiation is totally invisible. Use them for object detectors and communicators.

TRANSISTORS

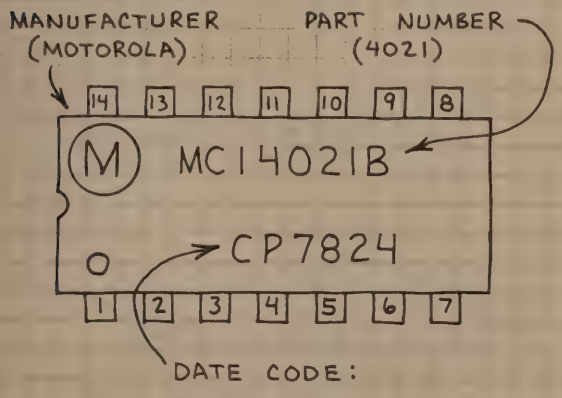
In this notebook, transistors are used as simple amplifiers and switches that turn on LEDs. Any general purpose switching transistors will work.

INTEGRATED CIRCUITS

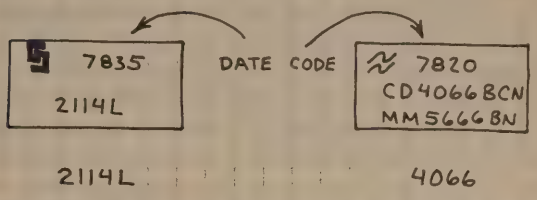
Since an IC is a complete circuit on a silicon chip, you must observe all operating restrictions. Reversed polarity, excessive supply voltage and sourcing or sinking too much current can destroy an IC. Be sure to pay close attention to the location of the power supply pins! Most ICs are packaged in 8, 14 or 16 pin plastic DIPs (Dual In-line Packages). A notch or circle is near pin 1:



When the IC is right side up, pin 1 is at lower left:



Incidentally, a date code may not be present, but other numbers may be...and the date code is not always below the device number:



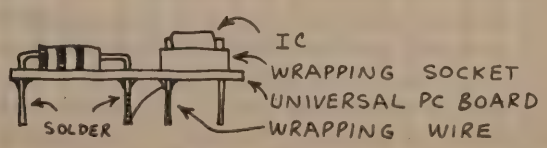
Store ICs in a plastic cabinet if you can afford one. Or insert them in rows in a styrofoam tray (the kind used for meat in a grocery store). CAUTION: Never store MOS/CMOS ICs in ordinary non-conductive plastic. See p. 12.

CIRCUIT BUILDING

Build your circuits on a solderless breadboard to make changes and find bugs. Then make permanent versions. Radio Shack plastic modular sockets (276-173, etc.) are ideal. They include two socket rows for power supply connections and snap rails for attaching sockets together. Parts and wires can be inserted directly into the holes in the socket.

For permanent circuits, use Radio Shack PC boards. Catalog numbers 276-024 and 276-151 are ideal for simple IC projects. Use larger universal PC boards for more complex projects (276-152 & 276-157). You can cut them into smaller sections with a nibbler tool or small saw.

I prefer to use wrapping wire for IC projects. Insert wrapping sockets in board and make connections with a Wire-Wrapping tool (such as 276-1570). Apply wrapping wire directly to leads of transistors, resistors, etc. and solder in place.



NOTES

DIGITAL INTEGRATED CIRCUITS

INTRODUCTION

DIGITAL ICs ARE 2-STATE DEVICES. ONE STATE IS NEAR 0 VOLTS OR GROUND (LOW OR L) AND THE OTHER IS NEAR THE IC'S SUPPLY VOLTAGE (HIGH OR H). SUBSTITUTE 0 FOR L AND 1 FOR H AND DIGITAL ICs CAN PROCESS INDIVIDUAL BINARY DIGITS (BITS) OR MULTIPLE BIT WORDS. A 4-BIT WORD IS A NIBBLE AND AN 8-BIT WORD IS A BYTE.

THE BINARY SYSTEM

IT'S VERY HELPFUL TO KNOW THE FIRST 16 BINARY NUMBERS. IF 0=L AND 1=H, THEY ARE:

0 - L L L L	8 - H L L L
1 - L L L H	9 - H L L H
2 - L L H L	10 - H L H L
3 - L L H H	11 - H L H H
4 - L H L L	12 - H H L L
5 - L H L H	13 - H H L H
6 - L H H L	14 - H H H L
7 - L H H H	15 - H H H H

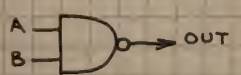
NOTE THAT LLLL (0) IS AS MUCH A NUMBER AS ANY OTHER NUMBER.

LOGIC GATES

LOGIC CIRCUITS ARE MADE BY INTER-CONNECTING TWO OR MORE OF THESE BASIC LOGIC GATES:

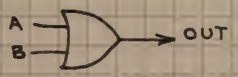
AND

A	B	OUT
L	L	L
L	H	L
H	L	L
H	H	H



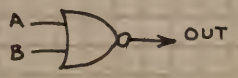
NAND

A	B	OUT
L	L	H
L	H	H
H	L	H
H	H	L



OR

A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	H

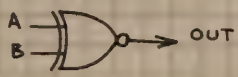


NOR

A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	L

EXCLUSIVE-OR

A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	L



EXCLUSIVE-NOR

A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	H

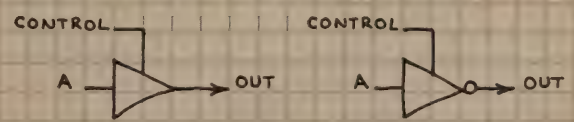
YES (BUFFER)

A	OUT
L	L
H	H

NOT (INVERTER)

A	OUT
L	H
H	L

3-STATE LOGIC



CONTROL	A	OUT
L	L	L
L	H	H
H	X	HI-Z

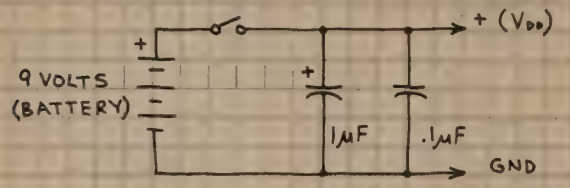
CONTROL	A	OUT
L	L	H
L	H	L
H	X	HI-Z

HI-Z: OUTPUT IN HIGH IMPEDANCE STATE.

MOS/CMOS INTEGRATED CIRCUITS

INTRODUCTION

MOS ICs CAN CONTAIN MORE FUNCTIONS PER CHIP THAN TTL/LS AND ARE VERY EASY TO USE. MOST CHIPS IN THIS SECTION ARE CMOS (COMPLEMENTARY MOS). THEY CONSUME VERY LITTLE POWER AND OPERATE OVER A +3-15 VOLT RANGE. CMOS CAN BE POWERED BY THIS:



OR YOU CAN USE A LINE POWERED SUPPLY MADE FROM A 7805/7812/7815. SEE THE LINEAR SECTION.

INCIDENTALLY, YOU CAN POWER A CMOS CIRCUIT FROM TWO SERIES CONNECTED PENLIGHT CELLS, BUT A 9-12 VOLT SUPPLY WILL GIVE BETTER PERFORMANCE.

OPERATING REQUIREMENTS

1. THE INPUT VOLTAGE SHOULD NOT EXCEED V_{DD}! (TWO EXCEPTIONS: THE 4049 AND 4050.)

2. AVOID, IF POSSIBLE, SLOWLY RISING AND FALLING INPUT SIGNALS SINCE THEY CAN CAUSE EXCESSIVE POWER CONSUMPTION. RISETIMES FASTER THAN 15 MICROSECONDS ARE BEST.

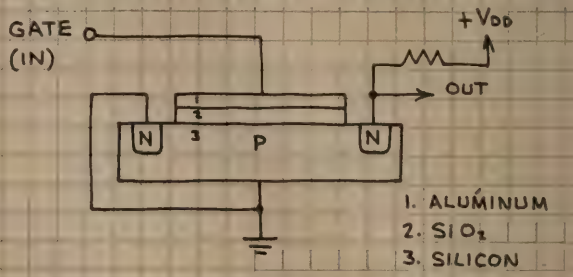
3. ALL UNUSED INPUTS MUST BE CONNECTED TO V_{DD} (+) OR V_{SS} (GND). OTHERWISE ERRATIC CHIP BEHAVIOR AND EXCESSIVE CURRENT CONSUMPTION WILL OCCUR.

4. NEVER CONNECT AN INPUT SIGNAL TO A CMOS CIRCUIT WHEN THE POWER IS OFF.

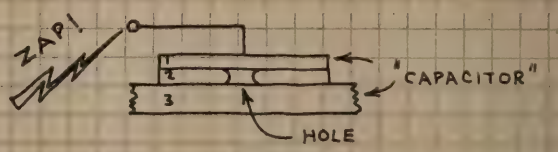
5. OBSERVE HANDLING PRECAUTIONS.

HANDLING PRECAUTIONS

A CMOS CHIP IS MADE FROM PMOS AND NMOS TRANSISTORS. MOS MEANS METAL - OXIDE - SILICON (OR SEMICONDUCTOR). P AND N REFER TO POSITIVE AND NEGATIVE CHANNEL MOS TRANSISTORS. AN NMOS TRANSISTOR LOOKS LIKE THIS:



A PMOS TRANSISTOR IS IDENTICAL EXCEPT THE P AND N REGIONS ARE EXCHANGED. THE SiO_2 (SILICON DIOXIDE) LAYER IS A GLASSY FILM THAT SEPARATES AND INSULATES THE METAL GATE FROM THE SILICON SUBSTRATE. THIS FILM IS WHY A MOS TRANSISTOR OR IC PLACES PRACTICALLY NO LOAD ON THE SOURCE OF AN INPUT SIGNAL. THE FILM IS VERY THIN AND IS THEREFORE EASILY PUNCTURED BY STATIC ELECTRICITY:



PREVENT STATIC DISCHARGE!

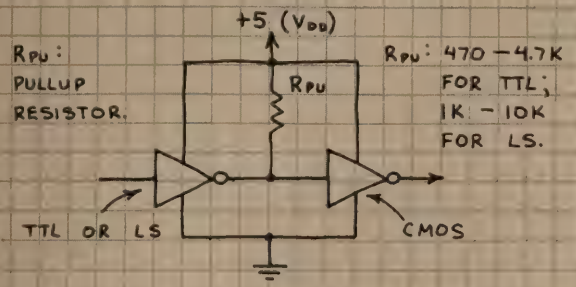
1. NEVER STORE MOS IC's IN NONCONDUCTIVE PLASTIC "SNOW," TRAYS, BAGS OR FOAM.

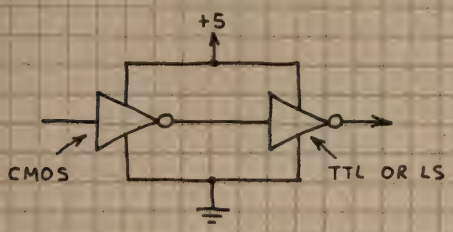
2. PLACE MOS IC's PINS DOWN ON AN ALUMINUM FOIL SHEET OR TRAY WHEN THEY ARE NOT IN A CIRCUIT OR STORED IN CONDUCTIVE FOAM.

3. USE A BATTERY POWERED IRON TO SOLDER MOS CHIPS. DO NOT USE AN AC POWERED IRON.

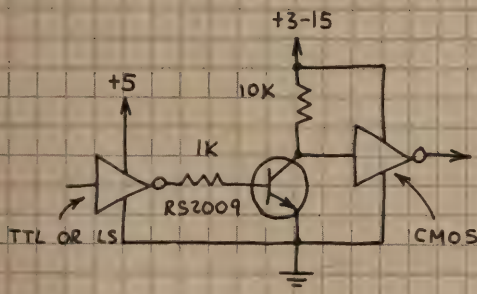
INTERFACING CMOS

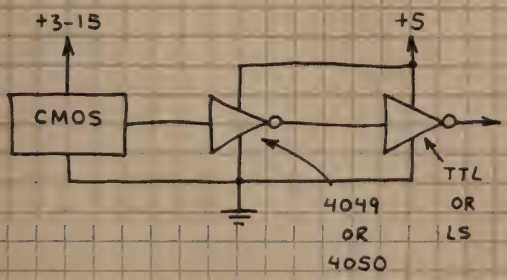
1. IF SUPPLY VOLTAGES ARE EQUAL:





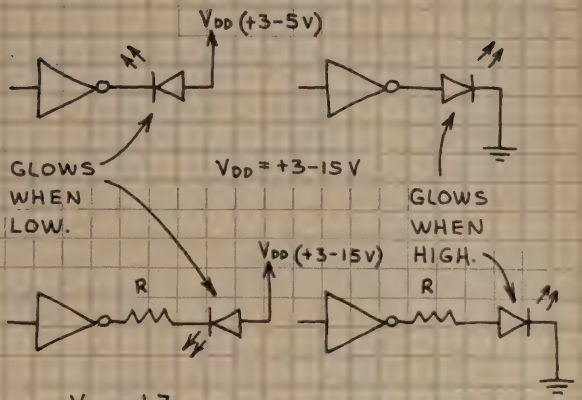
2. DIFFERENT SUPPLY VOLTAGES:





NOTE THAT CMOS MUST BE POWERED BY AT LEAST 5 VOLTS WHEN CMOS IS INTERFACED WITH TTL. OTHERWISE THE CMOS INPUT WILL EXCEED V_{DD}.

3. CMOS LED DRIVERS:

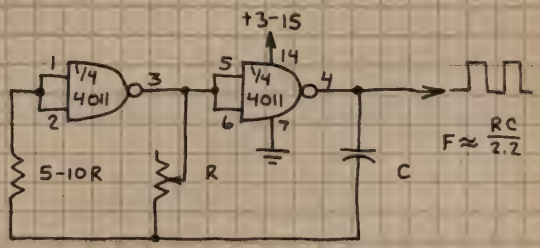


$$R = \frac{V_{DD} - 1.7}{.01}$$ (FOR 10 mA LED CURRENT)

USE 1000 OHMS FOR MOST APPLICATIONS.

CMOS LOGIC CLOCK

MANY CIRCUITS IN THIS SECTION REQUIRE A SOURCE OF PULSES. HERE'S A SIMPLE CMOS CLOCK:



TYPICAL VALUES: R = 100K, C = 0.01 – 0.1 μF

OK TO USE 4049 ... BUT MUCH MORE CURRENT WILL BE REQUIRED.

CMOS TROUBLESHOOTING

1. DO ALL INPUTS GO SOMEWHERE?

2. ARE ALL IC PINS INSERTED INTO THE BOARD OR SOCKET?

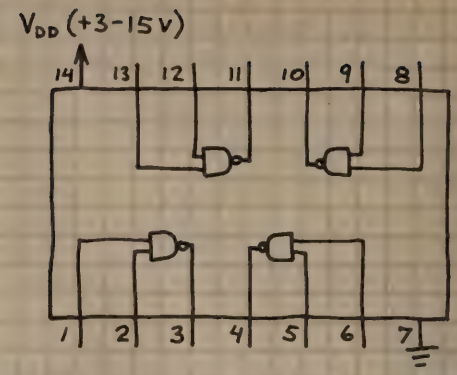
3. IS THE IC HOT? IF SO, SEE 1-2 ABOVE AND MAKE SURE THE OUTPUT IS NOT OVERLOADED.

4. DOES THE CIRCUIT OBEY ALL CMOS OPERATING REQUIREMENTS?

5. HAVE YOU FORGOTTEN A CONNECTION?

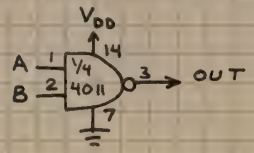
QUAD NAND GATE
4011

THE BASIC CMOS BUILDING BLOCK CHIP. MORE APPLICATIONS THAN TTL 7400/74LS00 QUAD NAND GATE.



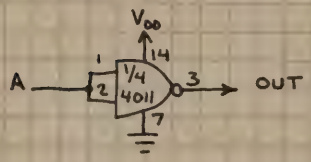
IMPORTANT: CONNECT ALL UNUSED INPUTS TO PIN 7 OR 14!

CONTROL GATE



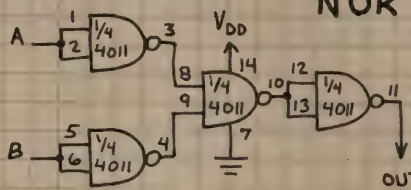
A	B	OUT
L	L	H
L	H	H
H	L	H
H	H	L

INVERTER



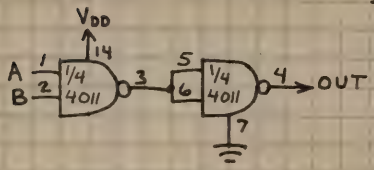
A	OUT
L	H
H	L

NOR GATE



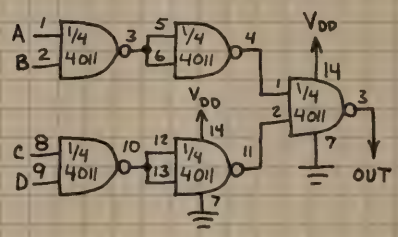
A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	L

AND GATE



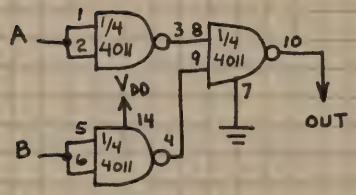
A	B	OUT
L	L	L
L	H	L
H	L	L
H	H	H

4-INPUT NAND GATE



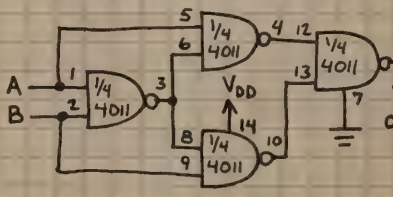
A	B	C	D	OUT
L	X	X	X	H
X	L	X	X	H
X	X	L	X	H
X	X	X	L	H
H	H	H	H	L

OR GATE



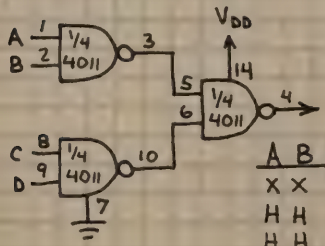
A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	H

EXCLUSIVE-OR GATE



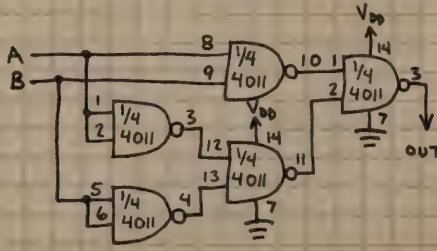
A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	L

AND-OR GATE



A	B	C	D	OUT
X	X	H	H	H
H	H	X	X	H
H	H	H	H	H

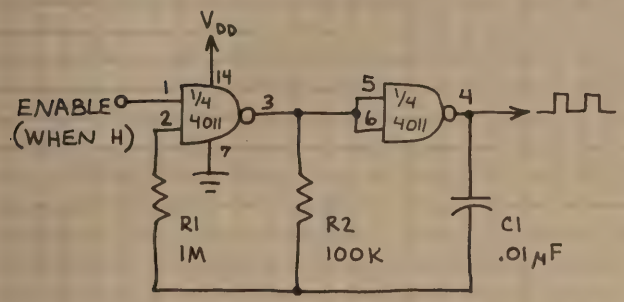
EXCLUSIVE-NOR GATE



A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	H

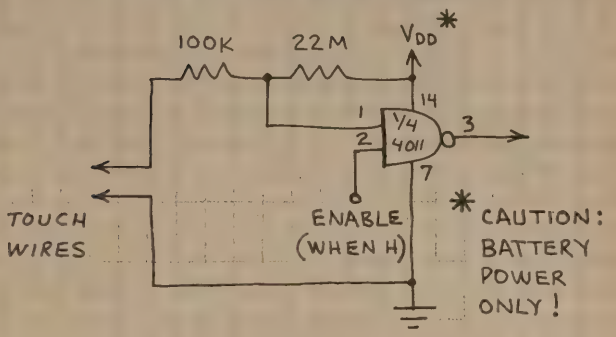
QUAD NAND GATE (CONTINUED)
4011

GATED OSCILLATOR



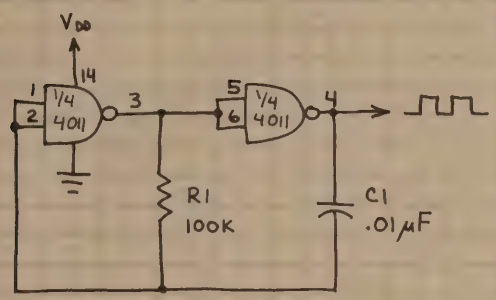
OUTPUT FREQUENCY IS 1 KHz SQUARE WAVE.

TOUCH SWITCH



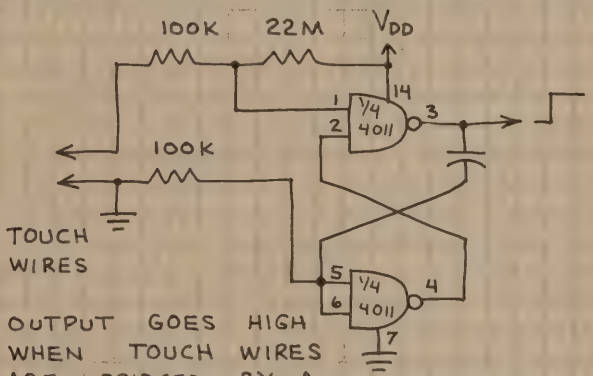
OUTPUT GOES HIGH WHEN TOUCH WIRES ARE BRIDGED BY A FINGER.

SIMPLE OSCILLATOR



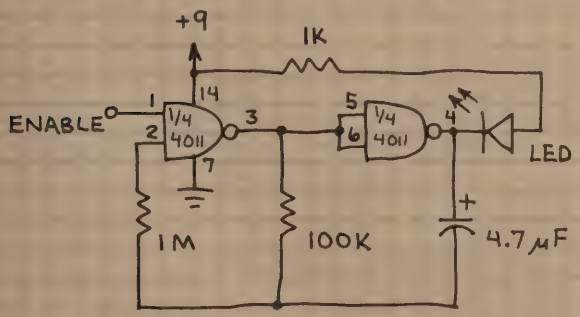
OUTPUT NOT AS SYMMETRICAL AS ABOVE CIRCUIT.

ONE-SHOT TOUCH SWITCH



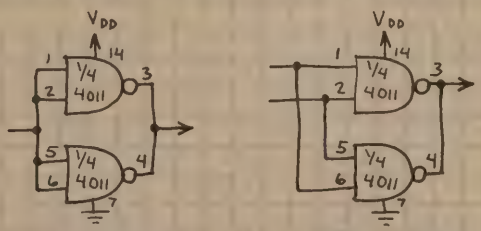
OUTPUT GOES HIGH WHEN TOUCH WIRES ARE BRIDGED BY A FINGER. OUTPUT THEN RETURNS LOW AFTER ABOUT 1 SECOND.

GATED FLASHER



LED FLASHES 1-2 Hz WHEN ENABLE IS HIGH. LED STAYS ON WHEN ENABLE IS LOW.

INCREASED OUTPUT DRIVE

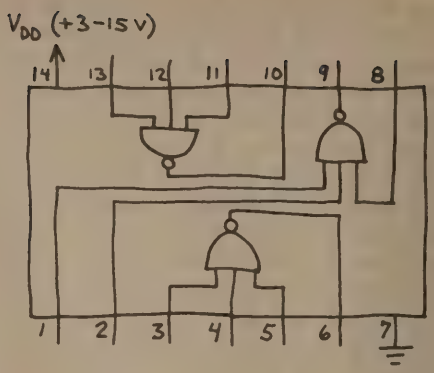


INVERTER NAND GATE

USE THIS METHOD TO INCREASE CURRENT THE 4011 CAN SOURCE OR SINK. OK TO ADD MORE GATES.

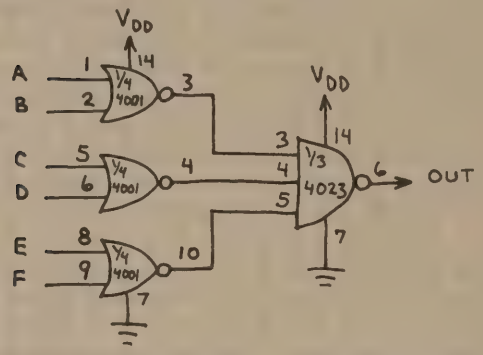
TRIPLE 3-INPUT NAND GATE 4023

HANDY FOR MAKING CUSTOM DECODERS, CONVERTERS AND MULTIPLE INPUT GATES.

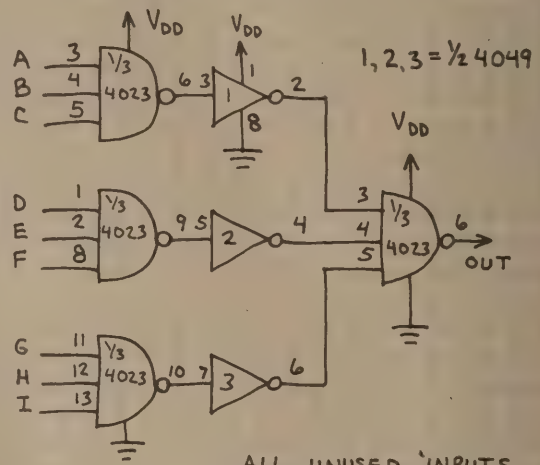


IMPORTANT: CONNECT ALL UNUSED INPUTS TO PIN 7 OR 14.

6-INPUT OR GATE



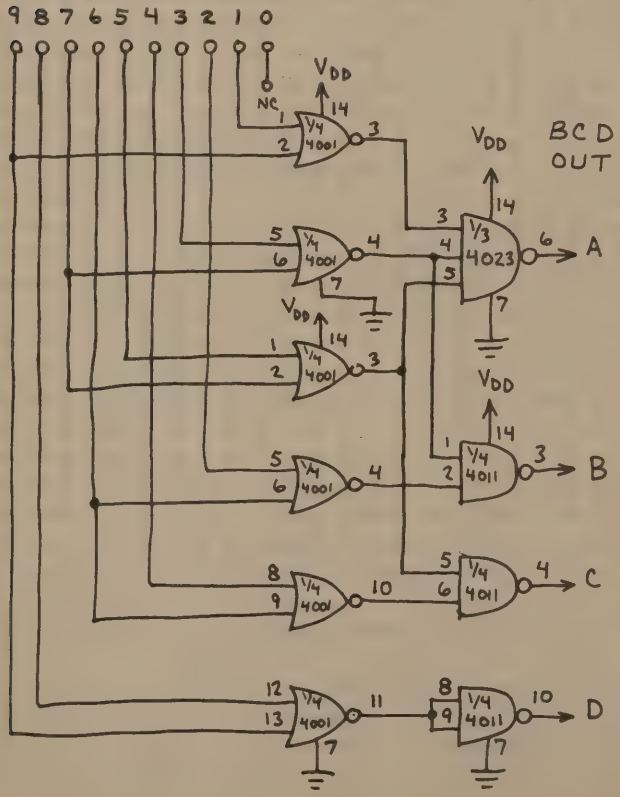
9-INPUT NAND GATE



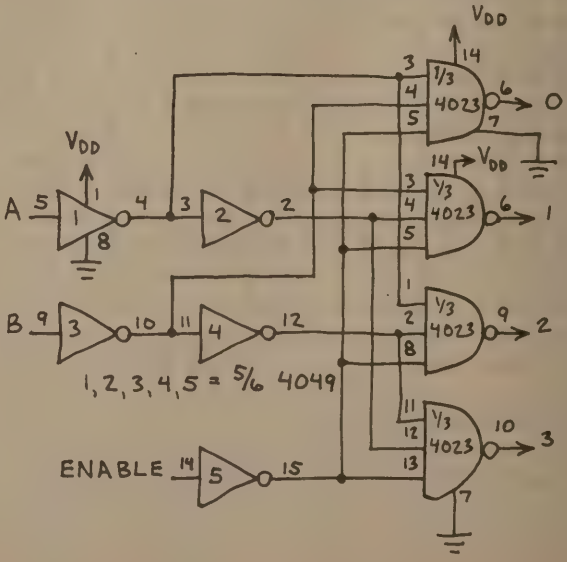
ALL UNUSED INPUTS MUST BE GROUNDED.

DECIMAL-TO-BCD CONVERTER

DECIMAL IN (SELECTED DIGIT H, ALL OTHERS L.)

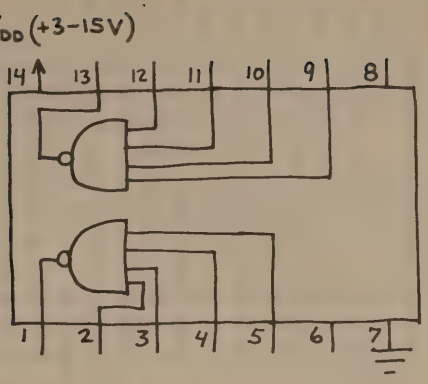


1-OF-4 DECODER

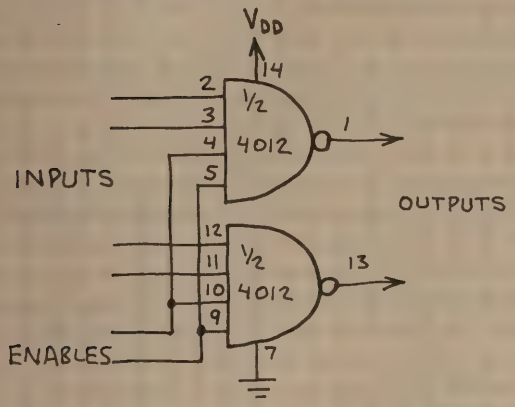


DUAL 4-INPUT NAND GATE 4012

VERY USEFUL IN MAKING DECODERS. ALSO CAN BE USED TO ADD ONE OR MORE ENABLE INPUTS TO VARIOUS CIRCUITS.

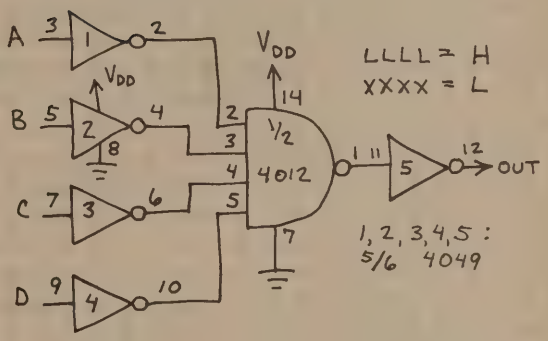


ENABLE INPUT

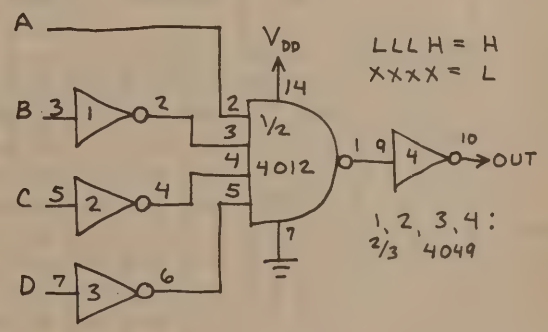


BCD DECODERS

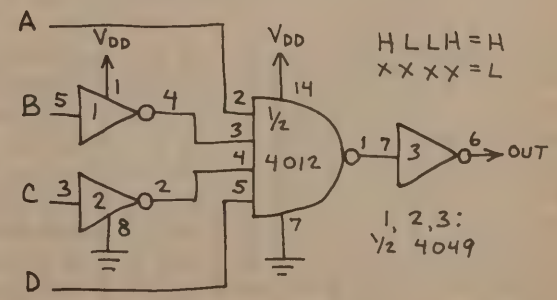
DECIMAL 0



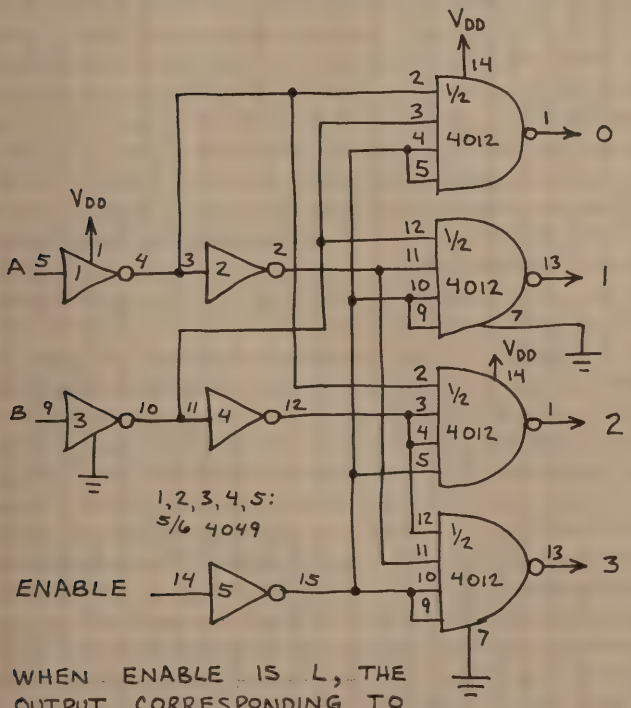
DECIMAL 1



DECIMAL 9



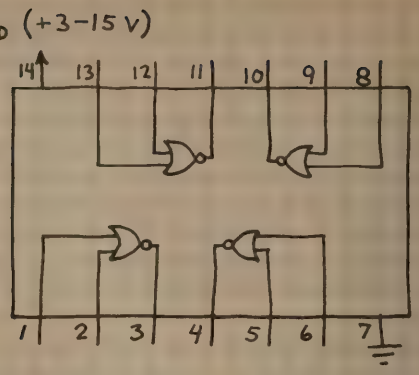
1-OF-4 DECODER



WHEN ENABLE IS L, THE OUTPUT CORRESPONDING TO THE BA BINARY INPUTS GOES LOW. ALL OTHER OUTPUTS GO HIGH WHEN ENABLE IS H.

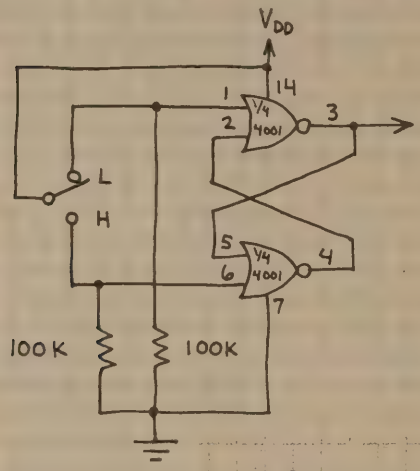
QUAD NOR GATE
4001

AN IMPORTANT CMOS BUILDING BLOCK CHIP. ITS HIGH IMPEDANCE INPUT MAKES POSSIBLE MORE APPLICATIONS THAN THE TTL 7402/74LS02 QUAD NOR GATE.

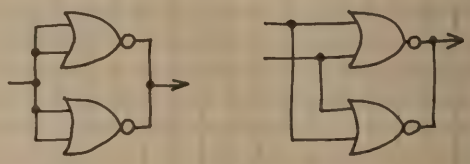


IMPORTANT: CONNECT ALL UNUSED INPUTS TO PIN 7 OR 14.

BOUNCELESS SWITCH



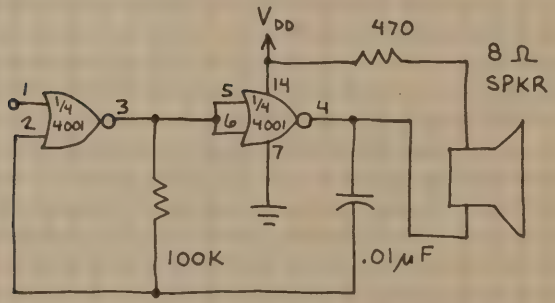
INCREASED OUTPUT DRIVE



INVERTER NOR GATE

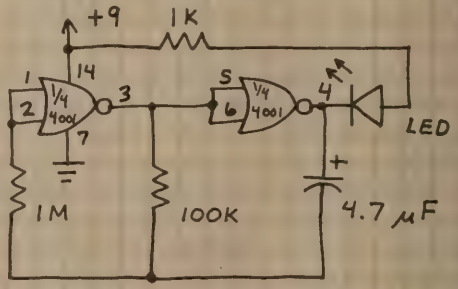
USE THIS METHOD TO INCREASE CURRENT THE 4001 CAN SOURCE OR SINK. OK TO ADD MORE GATES.

GATED TONE SOURCE



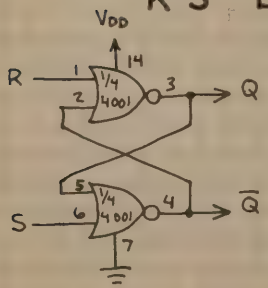
TONE FREQUENCY IS ABOUT 1KHz.

LED FLASHER



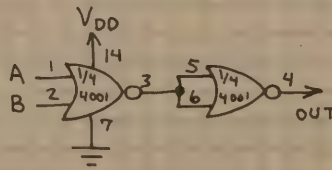
LED FLASHES 1-2 TIMES/SECOND.

RS LATCH



R	S	Q	$\overline{Q}$
L	L	NO CHANGE	
L	H	H	L
H	L	L	H
H	H	NOT ALLOWED	

OR GATE

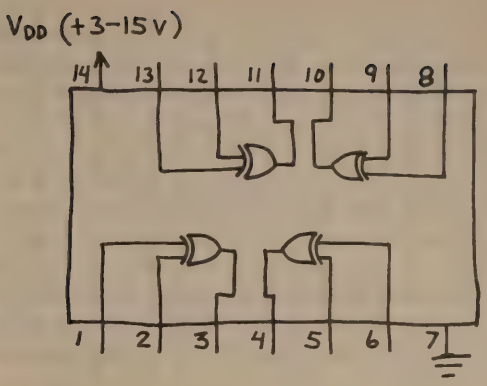


A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	H

QUAD EXCLUSIVE-OR GATE 4070

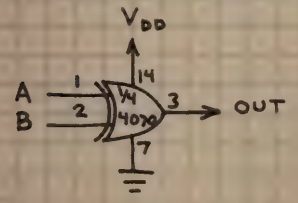
THE OUTPUT OF EACH GATE GOES LOW WHEN BOTH INPUTS ARE EQUAL. THE OUTPUT GOES HIGH IF THE INPUTS ARE UNEQUAL. MANY APPLICATIONS INCLUDING BINARY ADDITION, COMPARING BINARY WORDS AND PHASE DETECTION.

IMPORTANT: CONNECT UNUSED INPUTS TO PIN 7 OR 14.



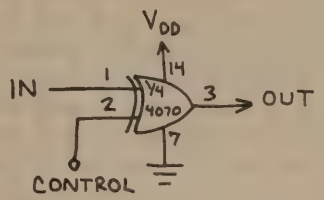
1-BIT COMPARATOR

THIS CIRCUIT IS ALSO A HALF-ADDER WITHOUT A CARRY OUTPUT.



A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	L

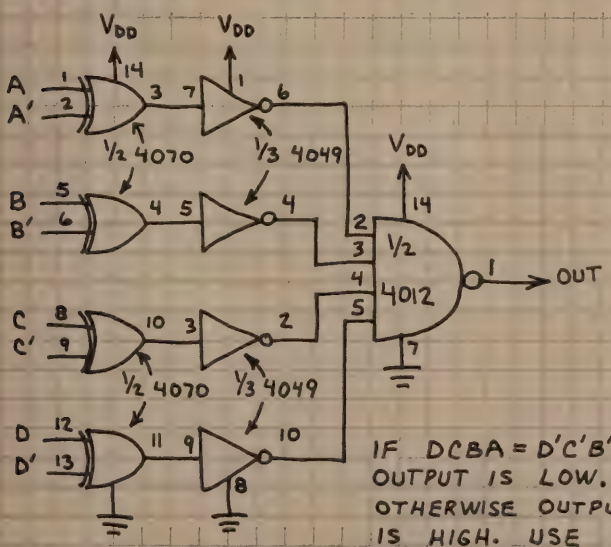
CONTROLLED INVERTER



L: IN = OUT
H: IN = $\overline{OUT}$

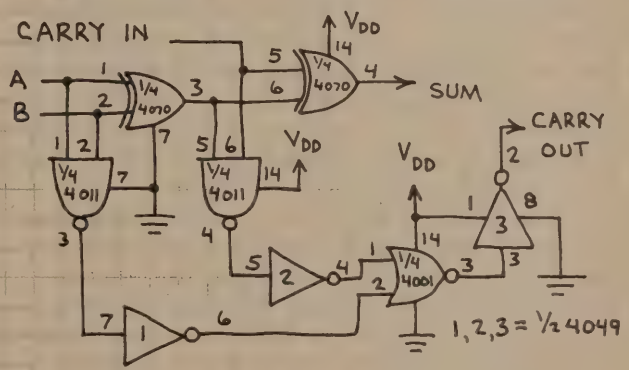
4-BIT COMPARATOR

DETERMINES IF TWO 4-BIT WORDS ARE EQUAL.

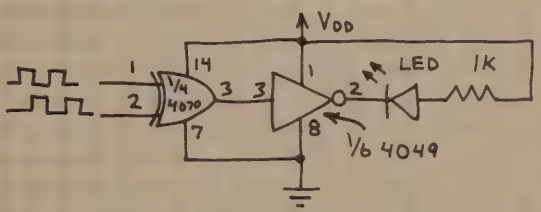


IF DCBA = D'C'B'A' OUTPUT IS LOW. OTHERWISE OUTPUT IS HIGH. USE SECOND HALF OF 4012 AS INVERTER TO REVERSE OPERATION.

BINARY FULL ADDER



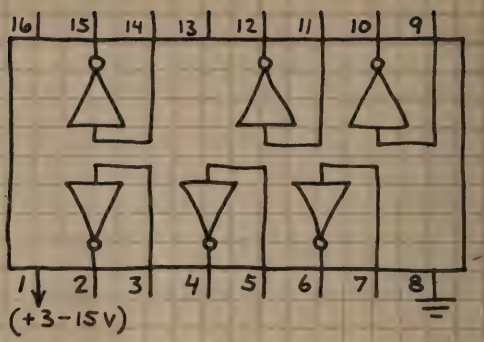
PHASE DETECTOR



LED STOPS GLOWING WHEN THE INPUT FREQUENCIES ARE EQUAL.

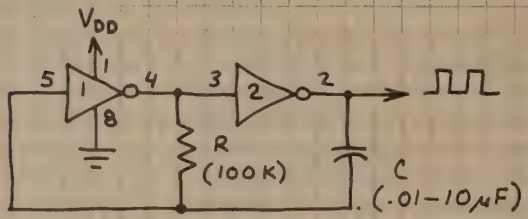
HEX INVERTING BUFFER 4049

IN ADDITION TO STANDARD LOGIC AND CMOS TO TTL INTERFACING, OFTEN USED IN OSCILLATORS AND PULSE GENERATORS. FOR LOW CURRENT APPLICATIONS, USE 4011 CONNECTED AS INVERTER. (OK TO USE 4011 FOR CIRCUITS ON THIS PAGE.)



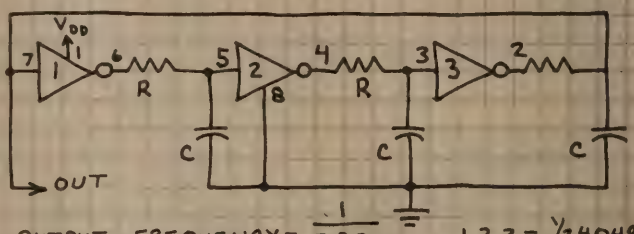
NOTE UNUSUAL LOCATION OF POWER SUPPLY PINS.

CLOCK PULSE GENERATOR



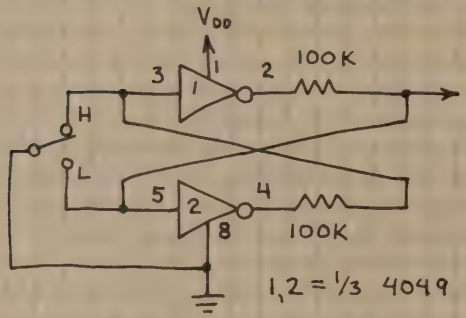
1,2 = 1/3 4049 PULSE RATE = $\frac{1}{1.4RC}$

PHASE SHIFT OSCILLATOR



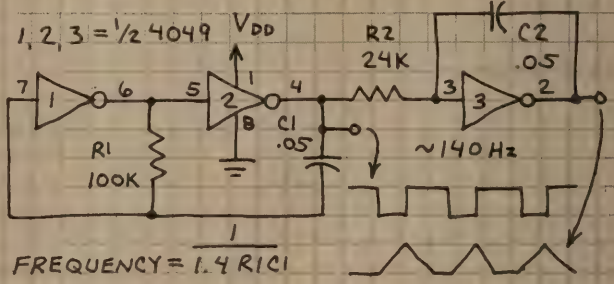
OUTPUT FREQUENCY = $\frac{1}{3.3RC}$ 1,2,3 = 1/2 4049

BOUNCELESS SWITCH



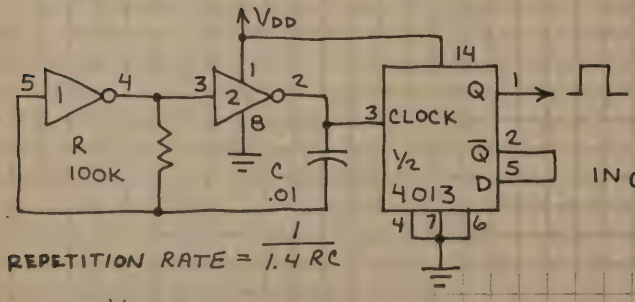
1,2 = 1/3 4049

TRIANGLE WAVE SOURCE



FREQUENCY = $\frac{1}{1.4R1C1}$

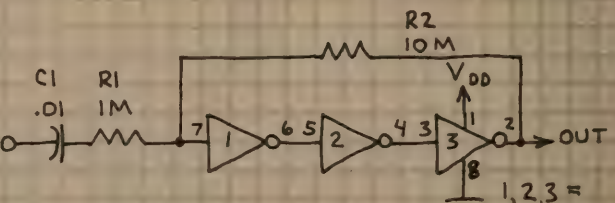
SQUARE WAVE GENERATOR



REPETITION RATE = $\frac{1}{1.4RC}$

1,2 = 1/3 4049

LINEAR 10X AMPLIFIER



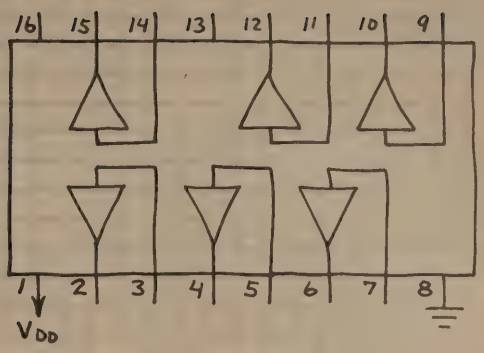
NOTE THAT THE INVERTERS ARE USED IN A LINEAR MODE. GAIN = R2/R1.

1,2,3 = 1/2 4049

HEX NON-INVERTING BUFFER
4050

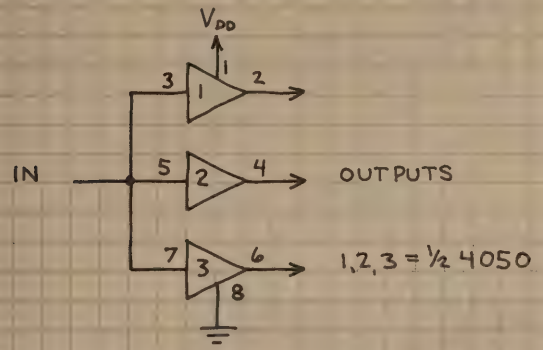
PRIMARILY INTENDED FOR INTERFACING CMOS TO TTL. SUPPLIES MORE CURRENT THAN STANDARD CMOS.

IMPORTANT: ALL UNUSED INPUTS MUST GO TO PIN 1 OR 8.

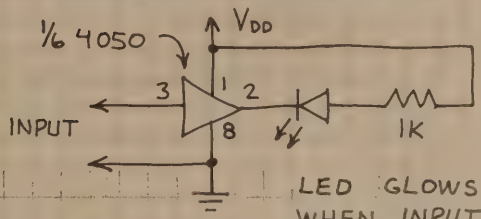


NOTE UNUSUAL LOCATION OF POWER SUPPLY PINS.

OUTPUT EXPANDER

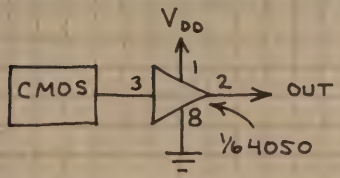


LOGIC PROBE

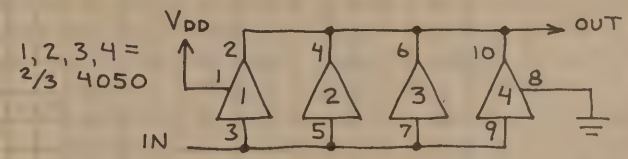


LED GLOWS WHEN INPUT IS LOW.

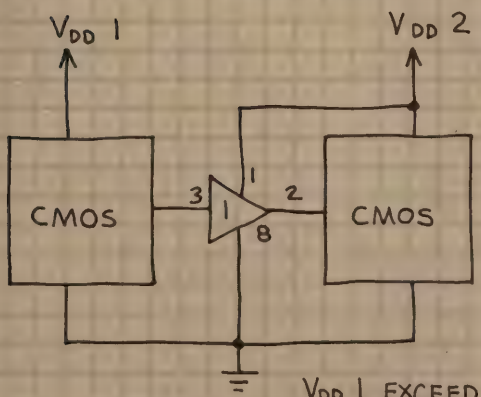
OUTPUT BUFFER



INCREASED OUTPUT DRIVE

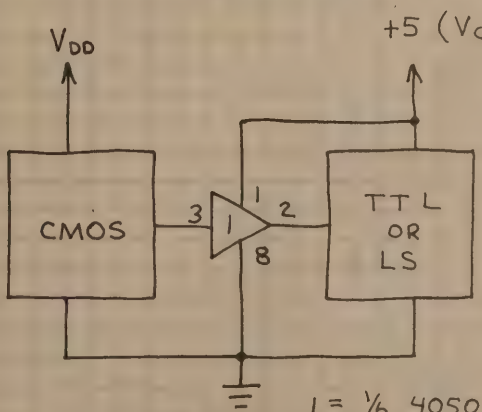


CMOS TO CMOS AT LOWER V_{DD}



VDD 1 EXCEEDS VDD 2.
1 = ⅙ 4050

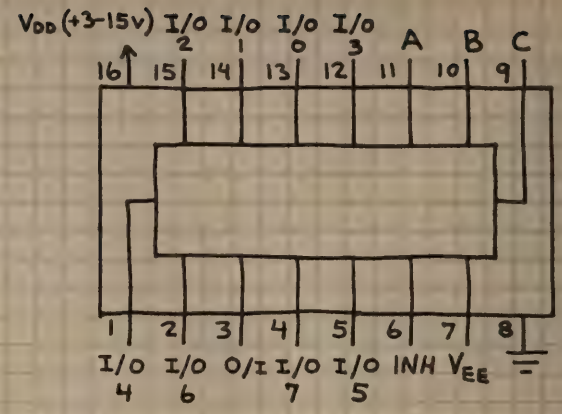
CMOS TO TTL/LS AT LOWER V_{CC}



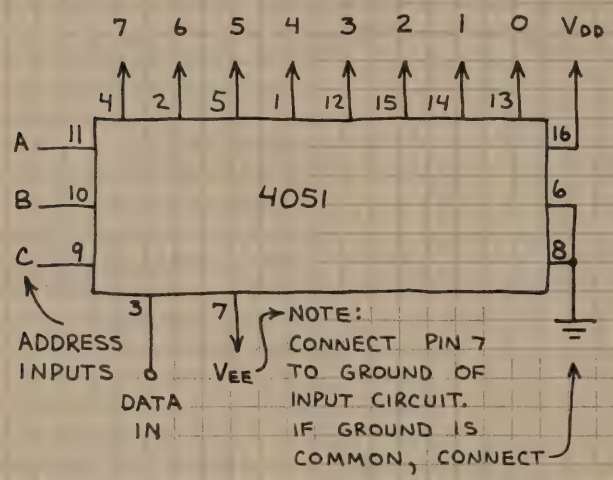
1 = ⅙ 4050

ANALOG MULTIPLEXER 4051

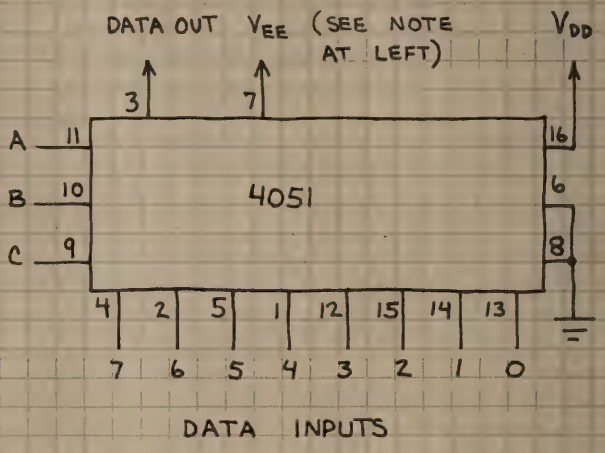
INPUT ADDRESS AT CBA SELECTS 1-OF-8 ANALOG SWITCHES. SIGNAL AT SELECTED SWITCH I/O (INPUT/OUTPUT) IS THEN APPLIED TO COMMON O/I (OUTPUT/INPUT). THE INPUT SIGNAL MUST NOT EXCEED V_{DD}. THE INHIBIT (INH) INPUT SHOULD BE GROUNDED FOR NORMAL OPERATION. ALL SWITCHES ARE OPEN WHEN INH IS HIGH.



1-OF-8 MULTIPLEXER

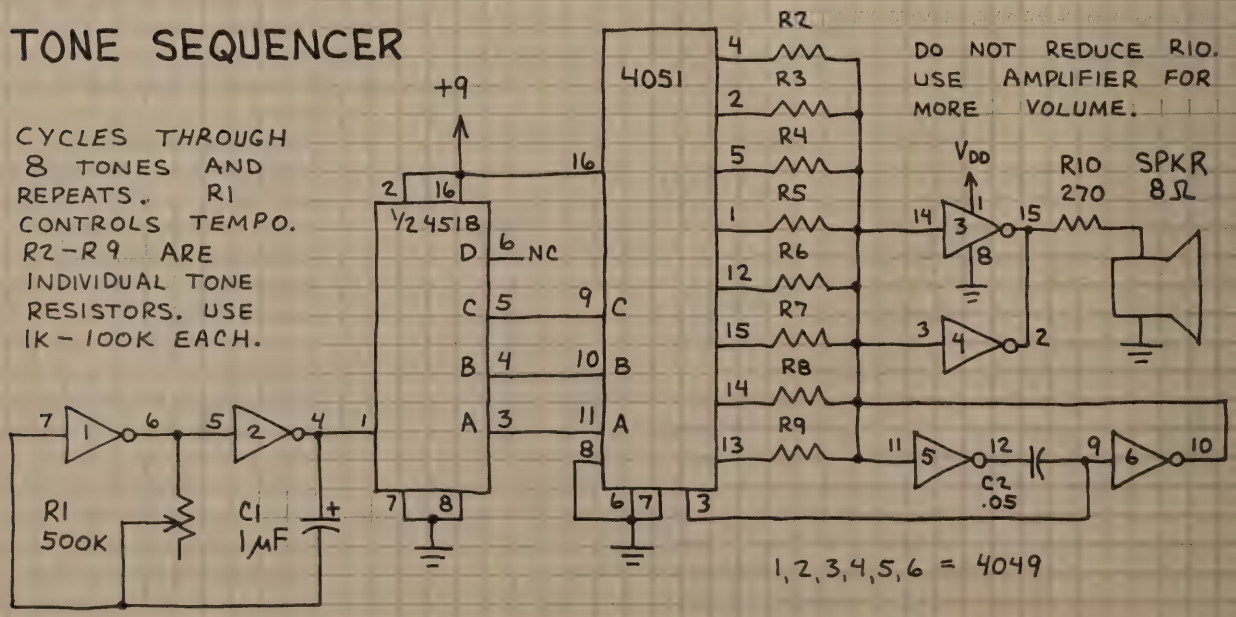


1-OF-8 DATA SELECTOR (DEMULTIPLEXER)



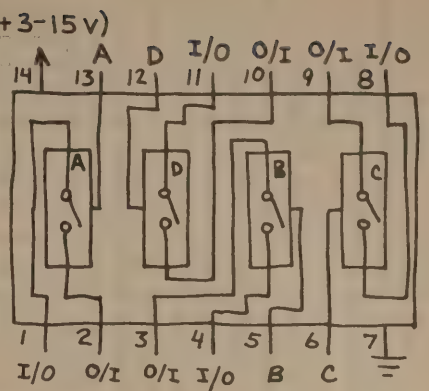
TONE SEQUENCER

CYCLES THROUGH 8 TONES AND REPEATS. R1 CONTROLS TEMPO. R2-R9 ARE INDIVIDUAL TONE RESISTORS. USE 1K-100K EACH.

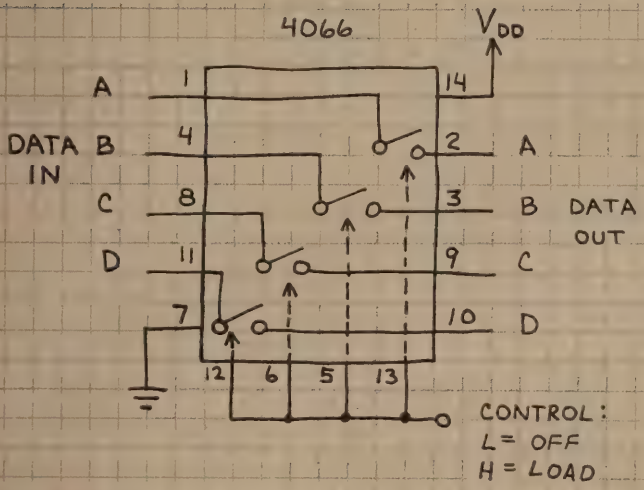


QUAD BILATERAL SWITCH
4066

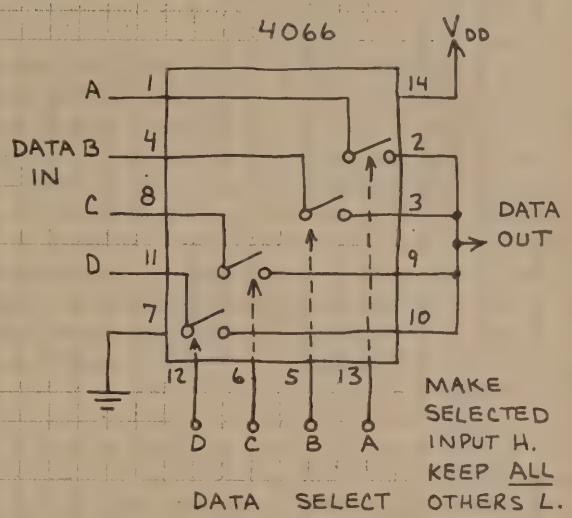
ONE OF THE MOST VERSATILE CMOS CHIPS. PINS A, B, C AND D CONTROL FOUR ANALOG SWITCHES. CLOSE A SWITCH BY CONNECTING ITS CONTROL PIN TO V_{DD}. ON RESISTANCE = 80–250 OHMS. OPEN A SWITCH BY CONNECTING ITS CONTROL PIN TO GROUND (PIN 7). OFF RESISTANCE = 10^9 OHMS. I/O (INPUT/OUTPUT) AND O/I PINS ARE REVERSIBLE.



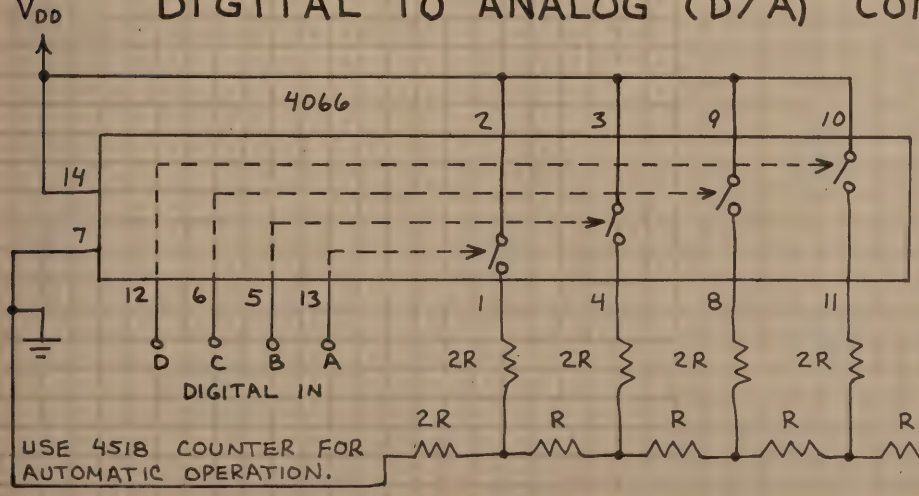
DATA BUS CONTROL



DATA SELECTOR

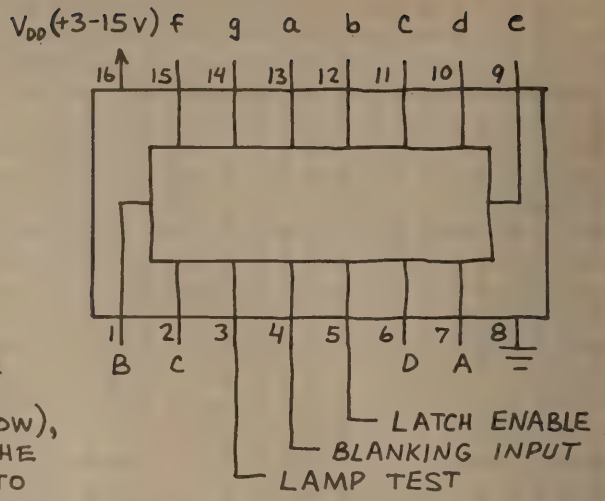


DIGITAL TO ANALOG (D/A) CONVERTER



THIS IS NOT A LINEAR D/A CONVERTER. INSTEAD IT PRODUCES A PSEUDO-RANDOM OUTPUT THAT RANGES FROM 3.06 – 5.62 VOLTS (V_{DD} = 9 V). USE TO DRIVE 4046 VCO OR PRODUCE UNUSUAL WAVEFORMS. R = 47K AND 2R = 100K.

BCD-TO-7-SEGMENT LATCH/DECODER/DRIVER 4511

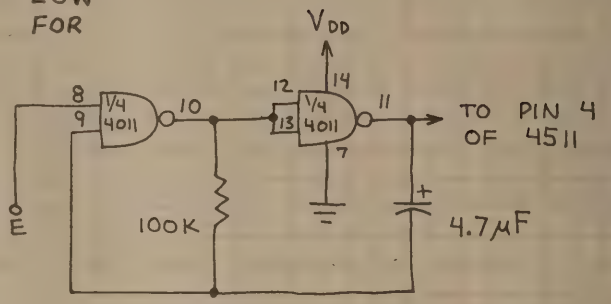


CONVERTS BCD DATA INTO FORMAT SUITABLE FOR PRODUCING DECIMAL DIGITS ON 7-SEGMENT LED DISPLAY. INCLUDES BUILT-IN 4-BIT LATCH TO STORE DATA TO BE DISPLAYED (WHEN PIN 5 IS HIGH). WHEN LATCH IS NOT USED (PIN5 LOW), THE 7-SEGMENT OUTPUTS FOLLOW THE BCD INPUTS. MAKE PIN 4 LOW TO EXTINGUISH THE DISPLAY AND HIGH FOR NORMAL OPERATION. MAKE PIN 3 LOW TO TEST THE DISPLAY AND HIGH FOR NORMAL OPERATION.

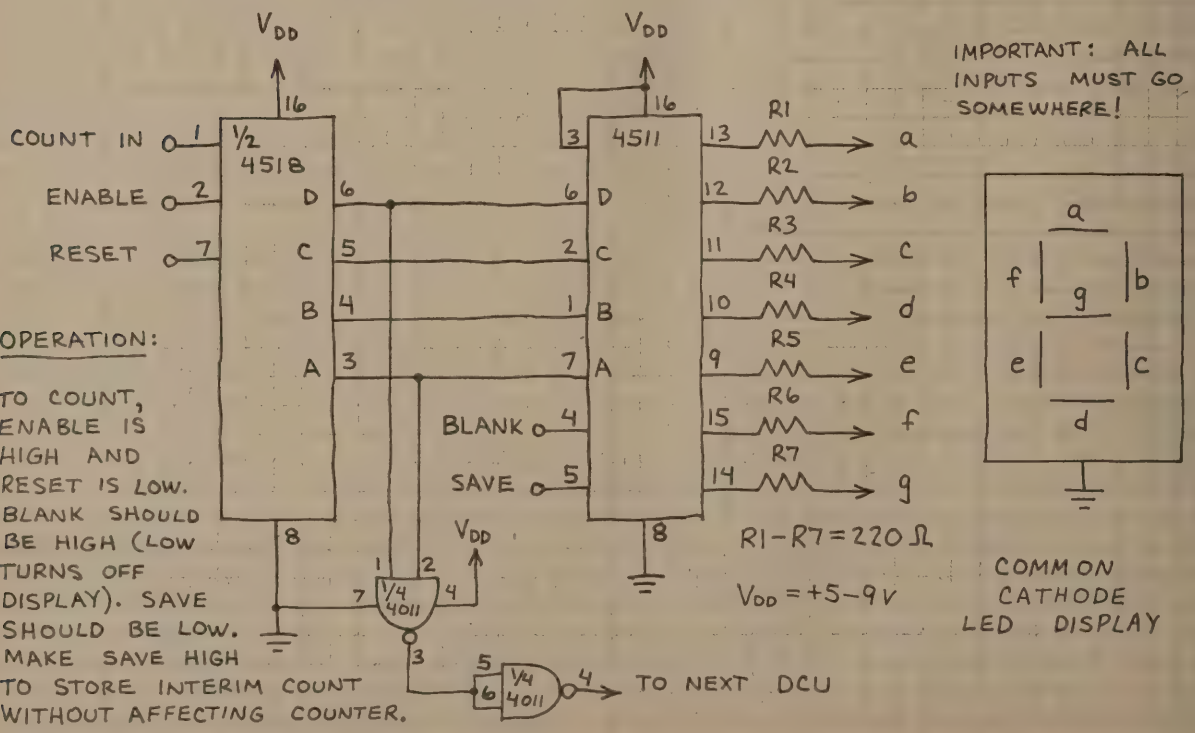
DISPLAY FLASHER

DISPLAY FLASHES ONCE PER SECOND WHEN E IS HIGH.

E	DISPLAY
H	FLASHES
L	OFF



DECIMAL COUNTING UNIT (DCU)

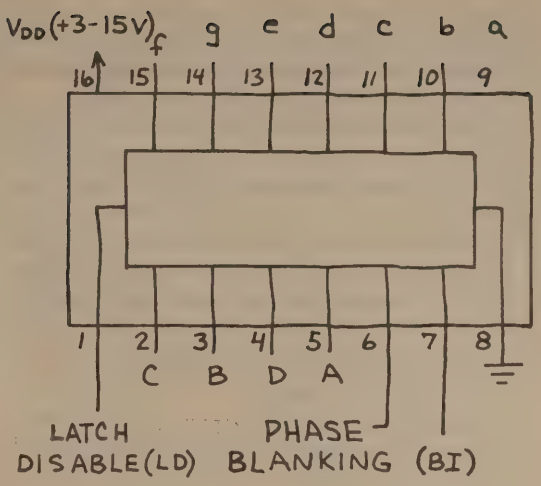


OPERATION:

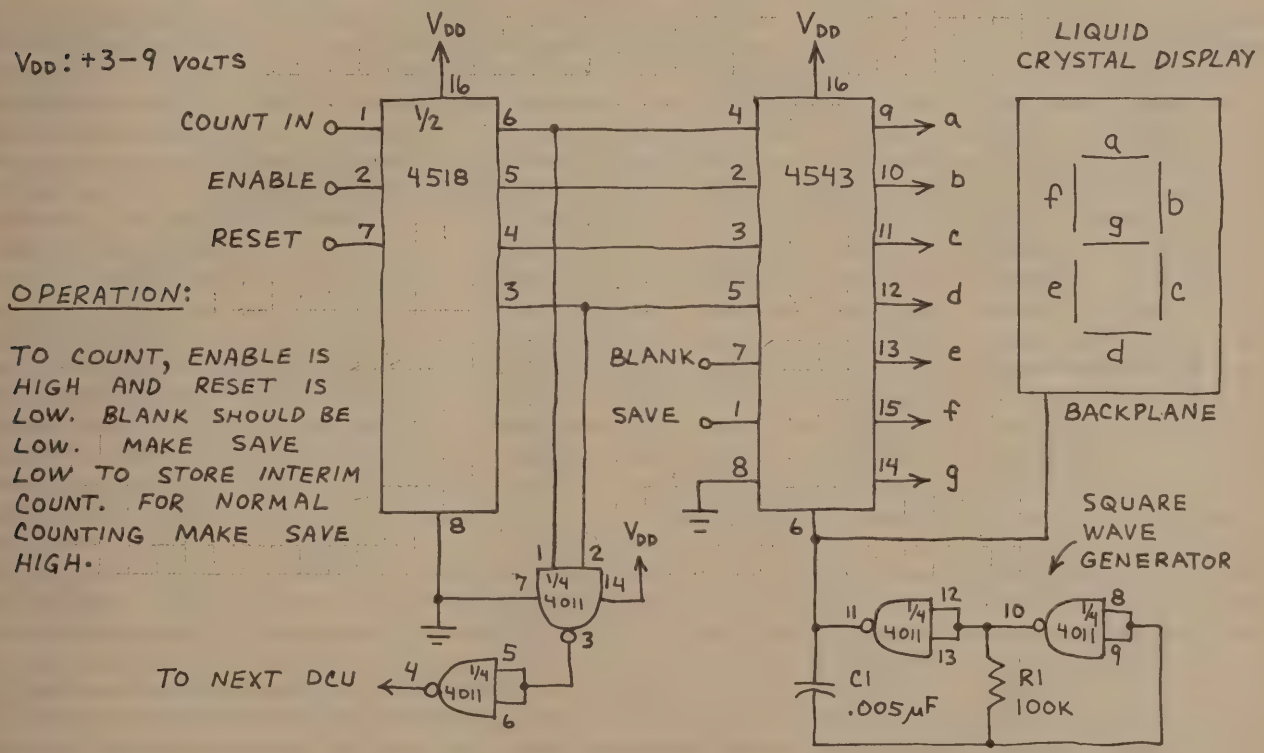
TO COUNT, ENABLE IS HIGH AND RESET IS LOW. BLANK SHOULD BE HIGH (LOW TURNS OFF DISPLAY). SAVE SHOULD BE LOW. MAKE SAVE HIGH TO STORE INTERIM COUNT WITHOUT AFFECTING COUNTER.

BCD-TO-7-SEGMENT LATCH/DECODER/DRIVER 4543 (14543)

DESIGNED TO DRIVE LIQUID CRYSTAL (LC) DISPLAYS BUT WILL DRIVE OTHER DISPLAYS ALSO. INCLUDES BUILT-IN 4-BIT LATCH TO STORE DATA TO BE DISPLAYED (WHEN PIN 1 IS LOW). WHEN LATCH IS NOT USED (PIN 1 HIGH), THE 7-SEGMENT OUTPUTS FOLLOW THE BCD INPUTS. MAKE PIN 7 HIGH TO BLANK THE DISPLAY AND LOW FOR NORMAL OPERATION.



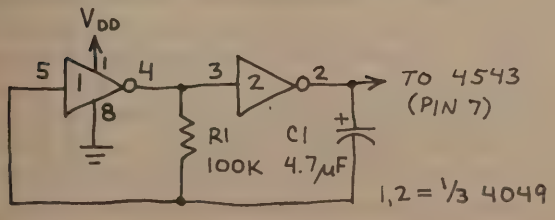
LIQUID CRYSTAL DISPLAY DECIMAL COUNTING UNIT



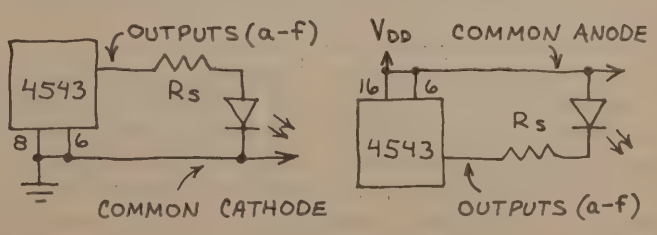
OPERATION:

TO COUNT, ENABLE IS HIGH AND RESET IS LOW. BLANK SHOULD BE LOW. MAKE SAVE LOW TO STORE INTERIM COUNT. FOR NORMAL COUNTING MAKE SAVE HIGH.

DISPLAY FLASHER

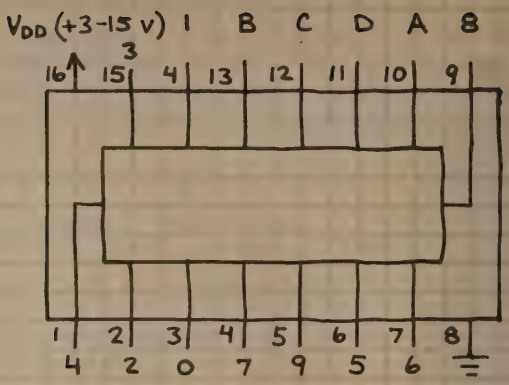


DRIVING LED DISPLAYS

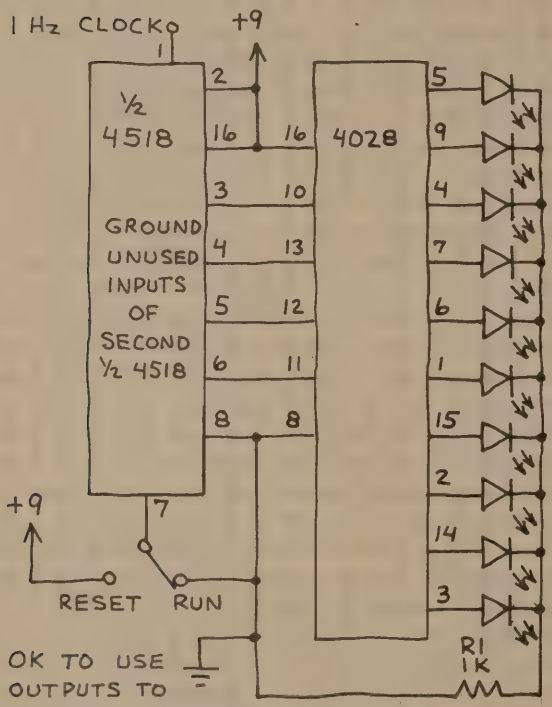


BCD-TO-DECIMAL DECODER 4028

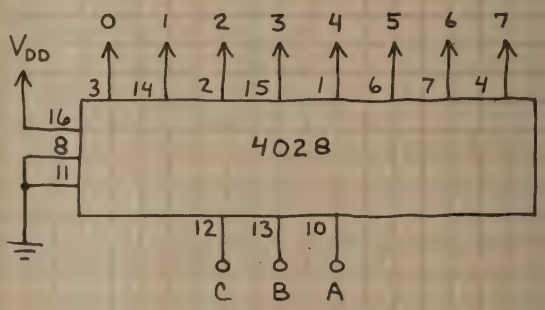
DECODES 4-BIT BCD INPUT INTO 1-OF-10 OUTPUTS. SELECTED OUTPUT GOES HIGH; ALL OTHERS STAY LOW. USE FOR DECIMAL READOUTS, SEQUENCERS, PROGRAMMABLE COUNTERS, ETC.



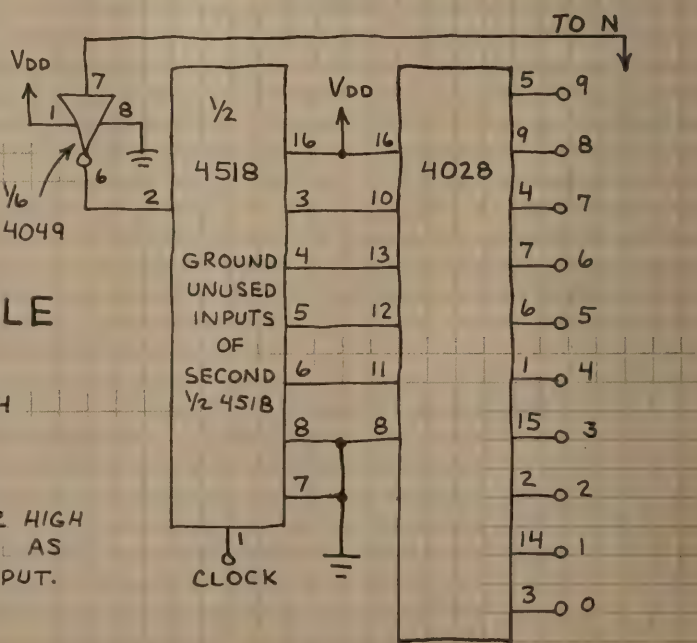
0-9 SECOND TIMER



1-OF-8 DECODER

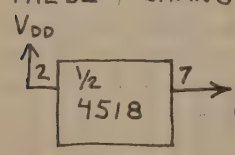


COUNT TO N AND HALT



COUNT TO N AND RECYCLE

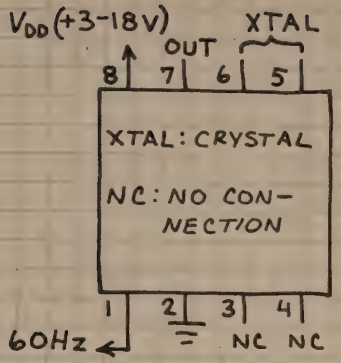
USE THE ADJACENT CIRCUIT WITH THESE CHANGES:



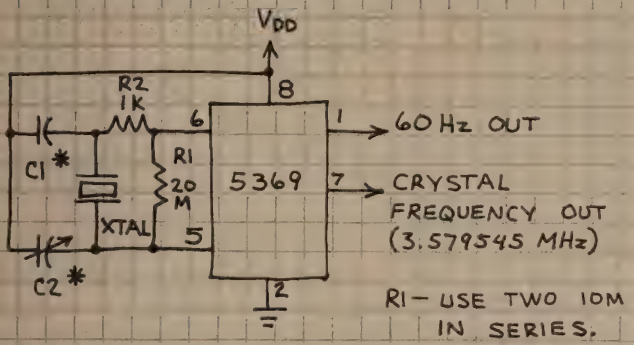
1. OMIT 4049
2. MAKE PIN 2 HIGH
3. USE PIN 7 AS CONTROL INPUT.

60-Hz TIMEBASE
MM5369 (276-1769)

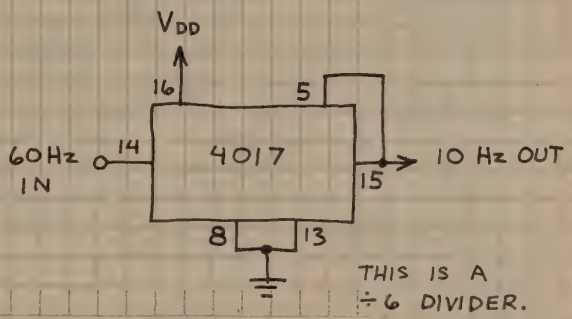
PROVIDES PRECISE 60 Hz SQUARE WAVE WHEN USED WITH 3.579545 MHz COLOR TV CRYSTAL. USE FOR MOST DO-IT-YOURSELF TIMERS, CLOCKS, CONTROLLERS, FUNCTION GENERATORS. INSTALL IN SMALL CABINET FOR WORKBENCH PRECISION CLOCK.



60-Hz TIMEBASE

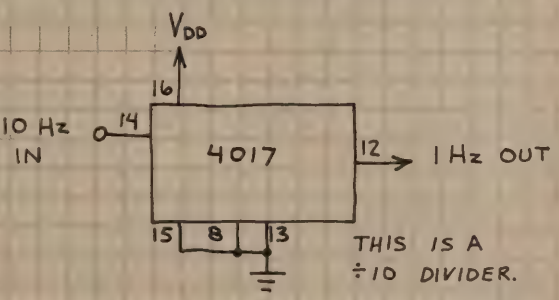


10-Hz TIMEBASE

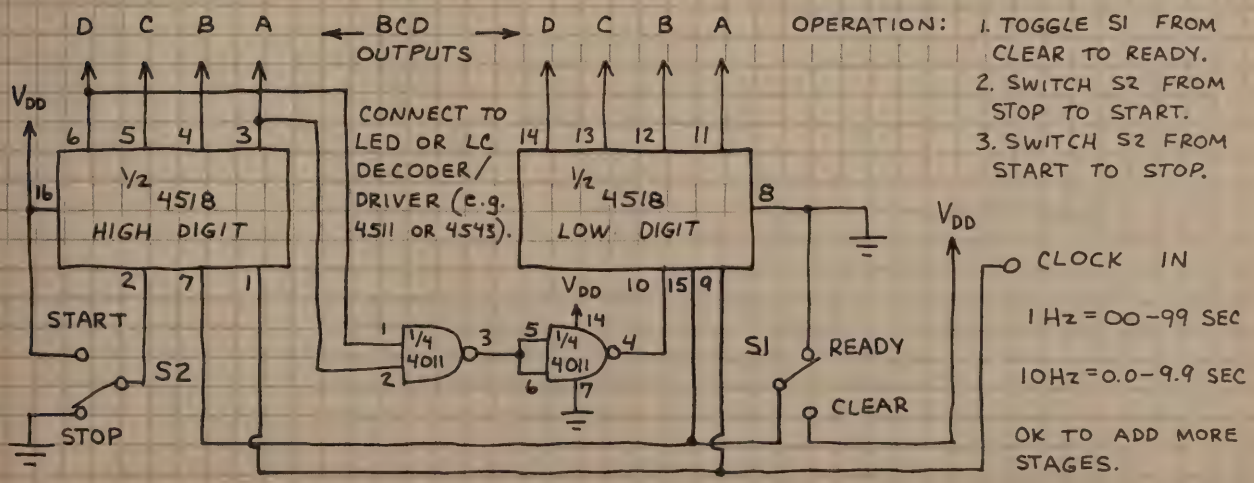


* MOTOROLA SPECIFIES THAT C1 = 30 pF AND C2 = 6.36 pF. OK TO USE SIX 4.7 pF CAPACITORS IN PARALLEL OR 47 pF CAPACITOR FOR C1. TRY TUNABLE CAPACITOR (e.g. 5-50 pF) FOR C2. TO TUNE, CONNECT FREQUENCY METER TO PIN 7. TUNE C2 UNTIL FREQUENCY IS 3,579,545 Hz. ACCURACY FAIRLY GOOD EVEN IF YOU DON'T TUNE C2.

1-Hz TIMEBASE



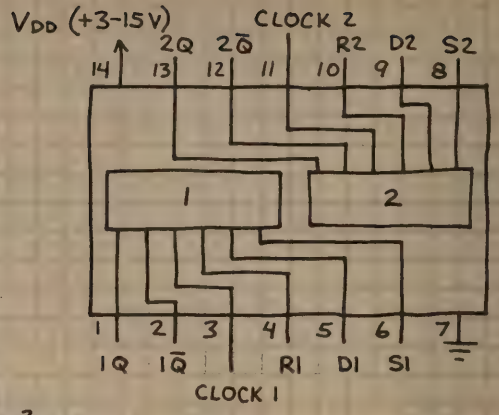
DIGITAL STOPWATCH



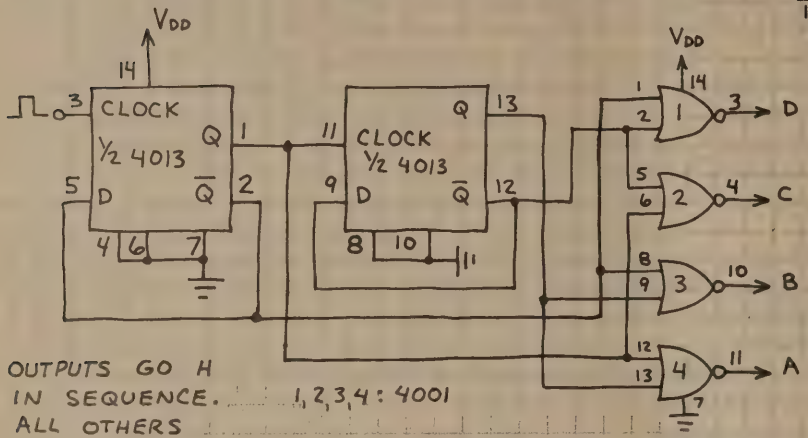
OPERATION:
1. TOGGLE S1 FROM CLEAR TO READY.
2. SWITCH S2 FROM STOP TO START.
3. SWITCH S2 FROM START TO STOP.

DUAL D FLIP-FLOP 4013

VERY VERSATILE PAIR OF D-TYPE FLIP-FLOPS. GROUND UNUSED INPUTS.

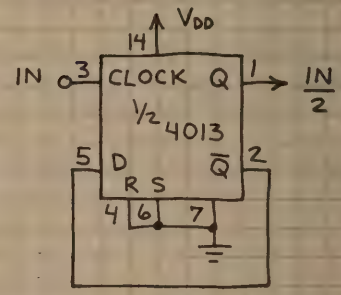


1-OF-4 SEQUENCER

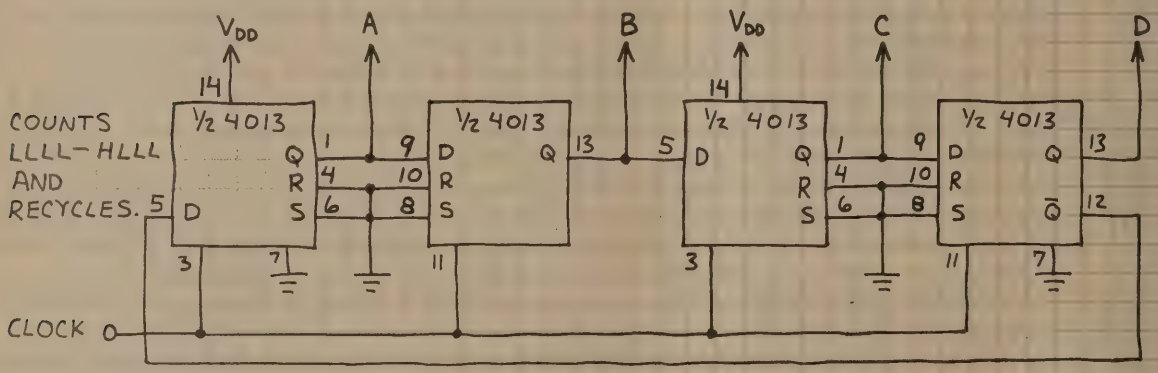


OUTPUTS GO H IN SEQUENCE. 1,2,3,4: 4001
ALL OTHERS STAY L.

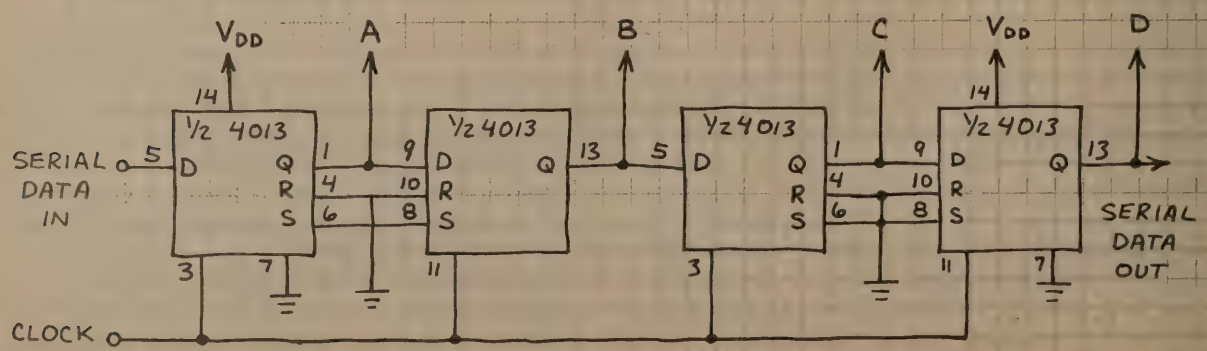
DIVIDE-BY-2



MODULO-8 COUNTER

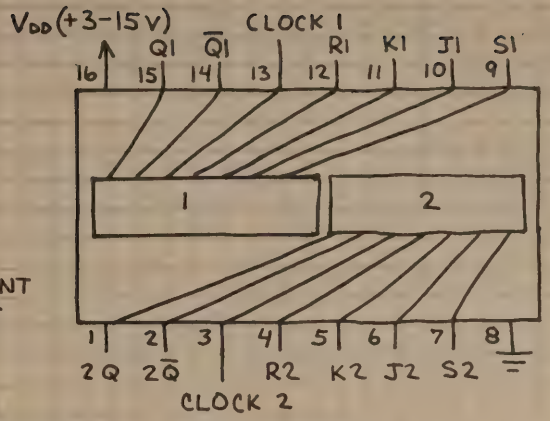


SERIAL IN/OUT, PARALLEL OUT SHIFT REGISTER

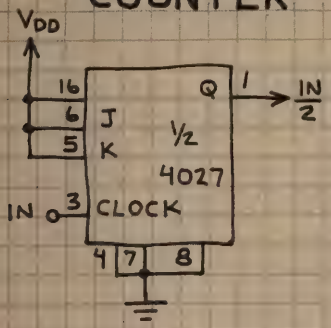


DUAL JK FLIP FLOP 4027

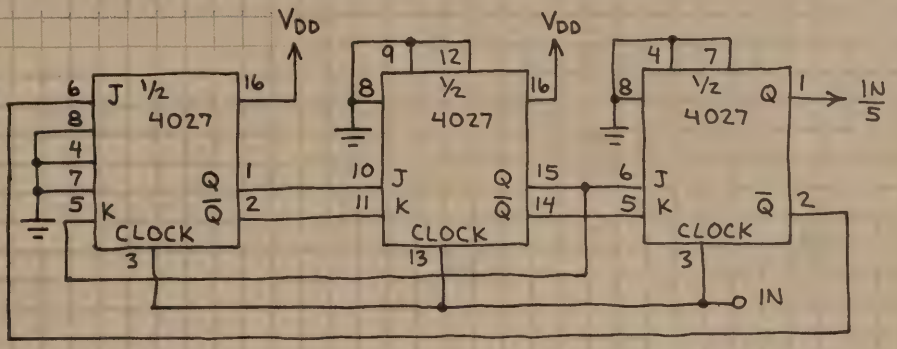
USE FOR DIVIDERS, COUNTERS AND REGISTERS. S (SET) AND R (RESET) INPUTS MUST BE LOW FOR CLOCKING TO OCCUR. MAKING S OR R HIGH SETS OR RESETS FLIP-FLOP INDEPENDENT OF CLOCK. IMPORTANT: ALL INPUTS MUST GO SOMEWHERE!



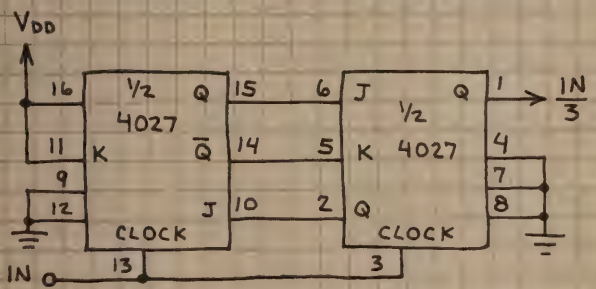
DIVIDE-BY-2 COUNTER



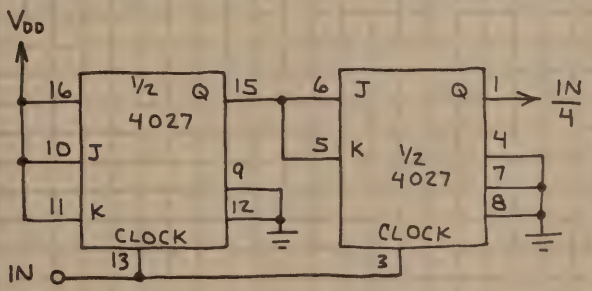
DIVIDE-BY-5 COUNTER



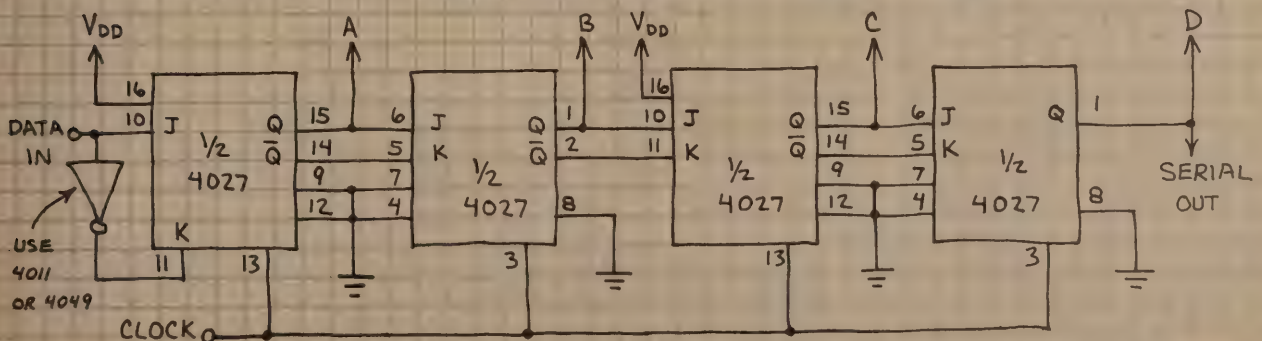
DIVIDE-BY-3 COUNTER



DIVIDE-BY-4 COUNTER

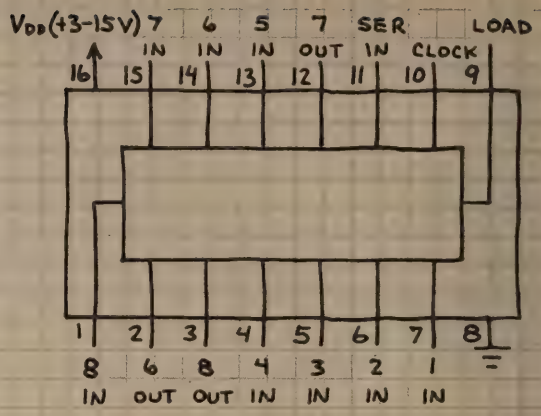


4-BIT SERIAL SHIFT REGISTER

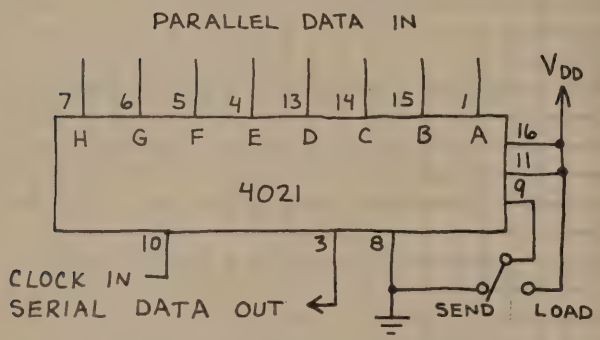


8-STAGE SHIFT REGISTER 4021

PARALLEL INPUT / SERIAL OUTPUT SHIFT REGISTER. ALSO SERIAL INPUT. DATA AT PARALLEL INPUTS IS FORCED INTO THE REGISTER IRRESPECTIVE OF THE CLOCK STATUS WHEN PIN 9 IS MADE HIGH. KEEP PIN 9 LOW FOR NORMAL OPERATION.

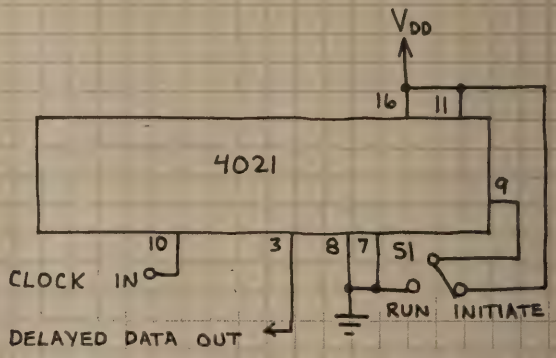


PARALLEL-TO-SERIAL DATA CONVERTER



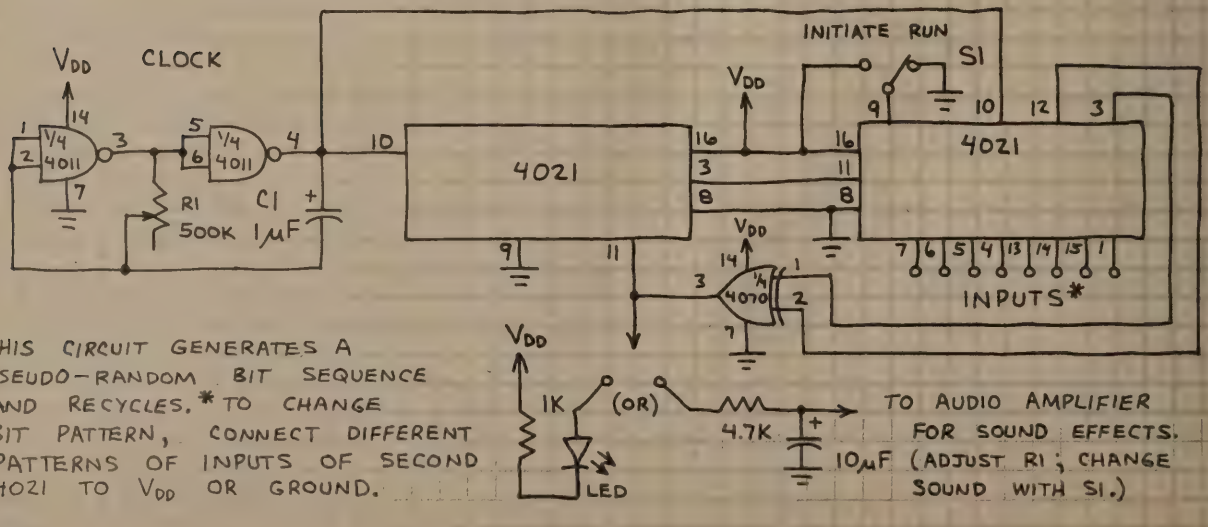
ALL 1's (H's) ARE SENT AFTER THE 8-BIT WORD IS TRANSMITTED.

8-STAGE DELAY LINE



THE FIRST PARALLEL INPUT (PIN 7) IS GROUNDED. THIS LOADS A SINGLE L WHEN SI IS SWITCHED TO INITIATE. THE SINGLE L BIT REACHES THE OUTPUT AFTER 8 CLOCK PULSES.

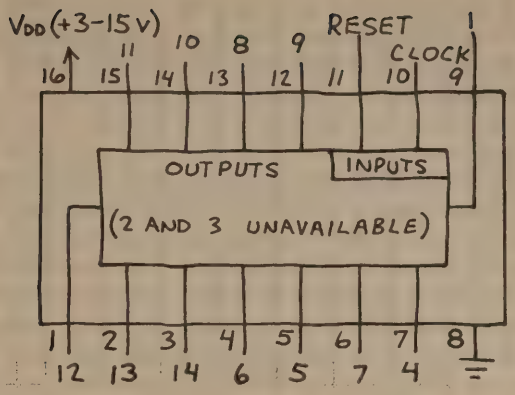
PSEUDO-RANDOM SEQUENCER



THIS CIRCUIT GENERATES A PSEUDO-RANDOM BIT SEQUENCE AND RECYCLES. * TO CHANGE BIT PATTERN, CONNECT DIFFERENT PATTERNS OF INPUTS OF SECOND 4021 TO V_{DD} OR GROUND.

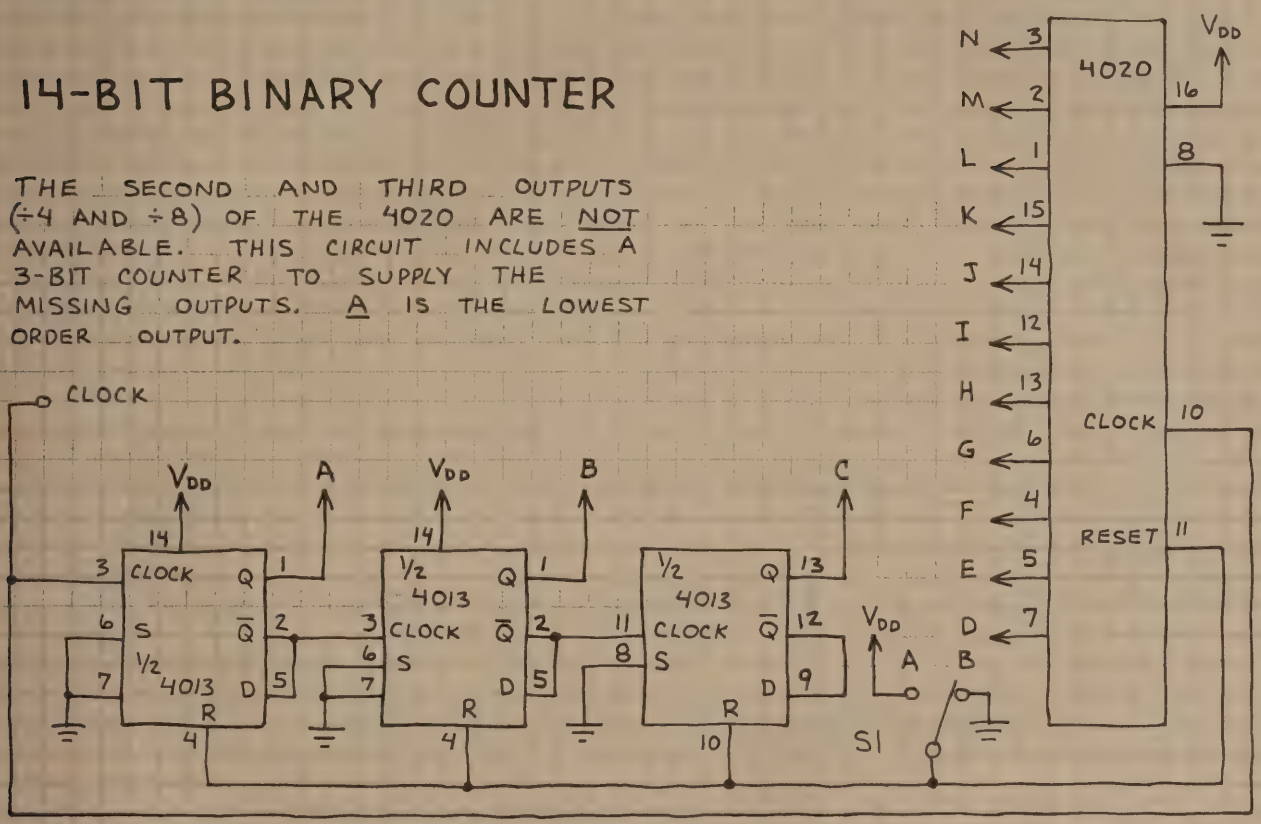
14-STAGE BINARY COUNTER 4020

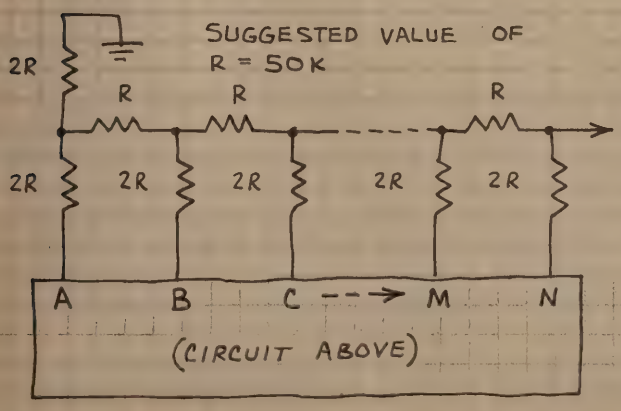
A RIPPLE COUNTER WITH CARRY OUTPUT. THE 14-STAGE BINARY COUNT IS COMPLETED IN 16,384 CLOCK PULSES. THIS MAKES POSSIBLE VERY LONG DURATION TIMERS, ASSUMING THE OUTPUTS ARE DECODED. THE OUTPUTS REQUIRE A BRIEF SETTLING TIME AFTER EACH CLOCK PULSE.



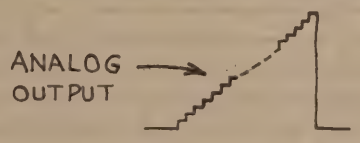
14-BIT BINARY COUNTER

THE SECOND AND THIRD OUTPUTS (÷4 AND ÷8) OF THE 4020 ARE NOT AVAILABLE. THIS CIRCUIT INCLUDES A 3-BIT COUNTER TO SUPPLY THE MISSING OUTPUTS. A IS THE LOWEST ORDER OUTPUT.





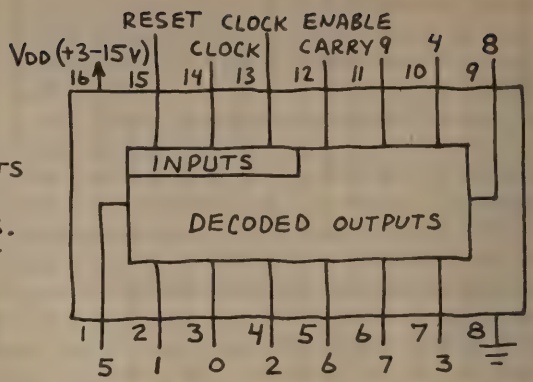
STAIRCASE GENERATOR



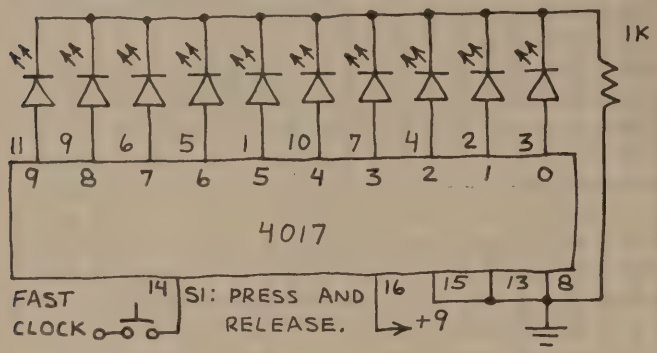
OUTPUT IS A STEPPED VOLTAGE. APPLICATIONS INCLUDE ANALOG-TO-DIGITAL CONVERSION AND WAVEFORM SYNTHESIS.

DECADE COUNTER/DECODER 4017

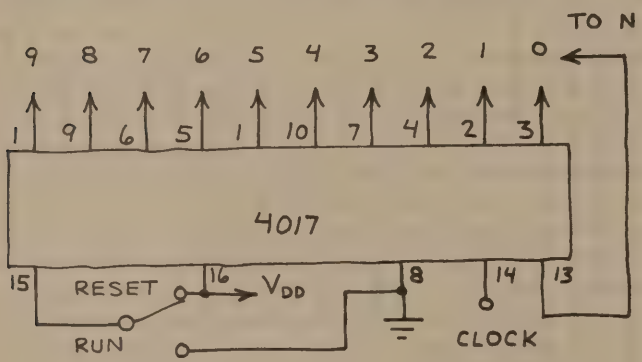
SEQUENTIALLY MAKES 1-OF-10 OUTPUTS HIGH (OTHERS STAY LOW) IN RESPONSE TO CLOCK PULSES. MANY APPLICATIONS. COUNT TAKES PLACE WHEN PINS 13 AND 15 ARE LOW.



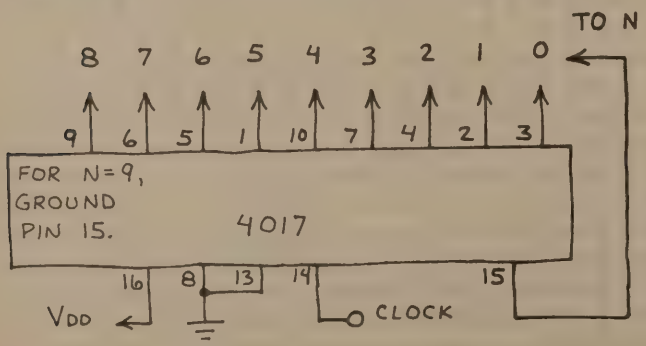
RANDOM NUMBER GENERATOR



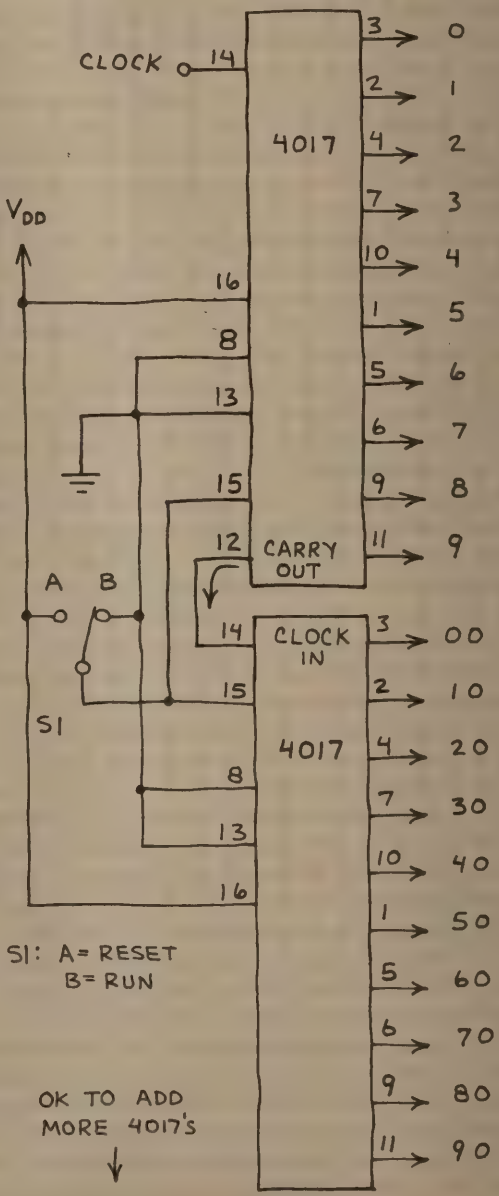
COUNT TO N AND HALT



COUNT TO N AND RECYCLE

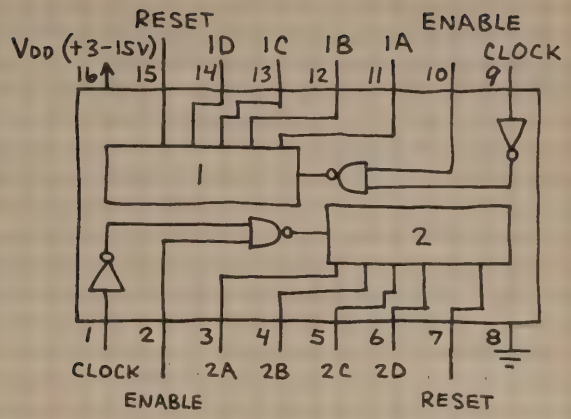


0-99 COUNTER

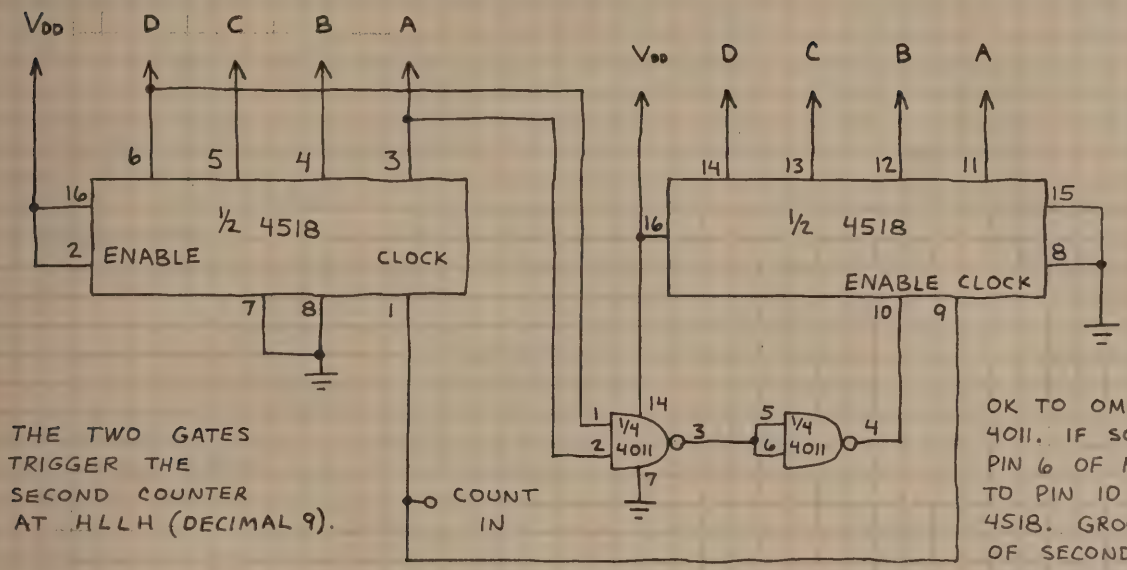


DUAL BCD COUNTER 4518

TWO SYNCHRONOUS DECADE COUNTERS IN ONE PACKAGE. WHEN ENABLE IS HIGH AND RESET IS LOW, EACH COUNTER ADVANCES ONE COUNT PER CLOCK PULSE.



CASCADED BCD COUNTERS

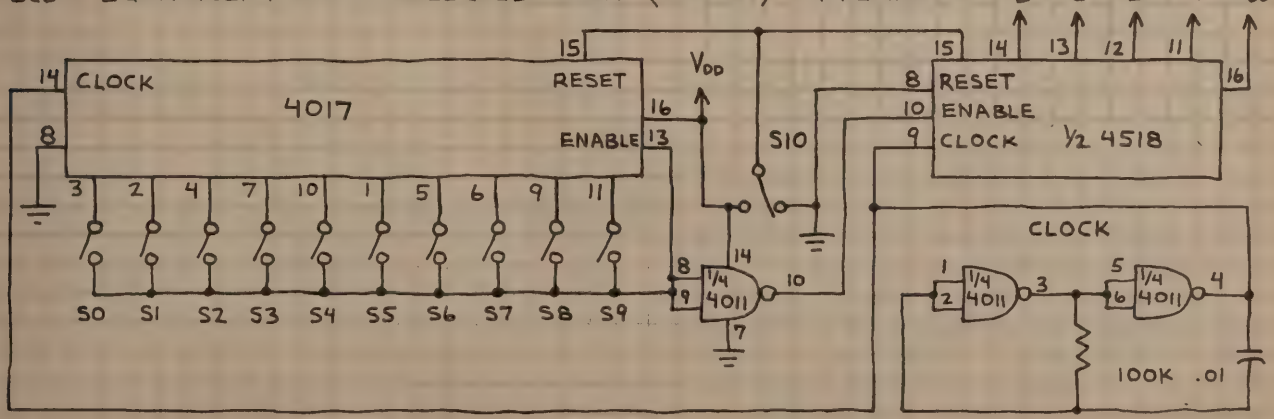


THE TWO GATES TRIGGER THE SECOND COUNTER AT HLLH (DECIMAL 9).

OK TO OMIT THE 4011. IF SO, CONNECT PIN 6 OF FIRST 4518 TO PIN 10 OF SECOND 4518. GROUND PIN 9 OF SECOND 4518 AND APPLY INPUT TO PIN 1 OF FIRST 4518.

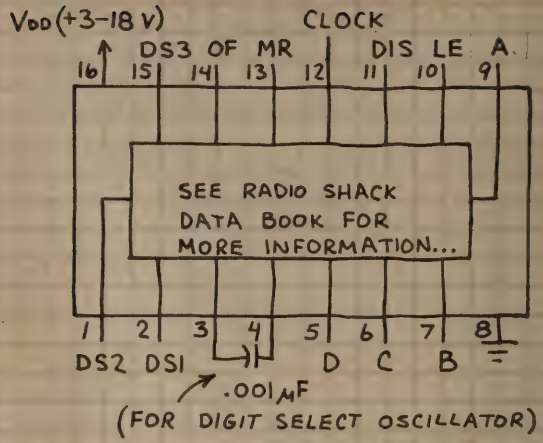
BCD KEYBOARD ENCODER

PRESS S0-S9, THEN TOGGLE RESET SWITCH S10 TO VDD AND BACK TO GROUND.
BCD EQUIVALENT OF SELECTED KEY (S0-S9) APPEARS → D C B A VDD

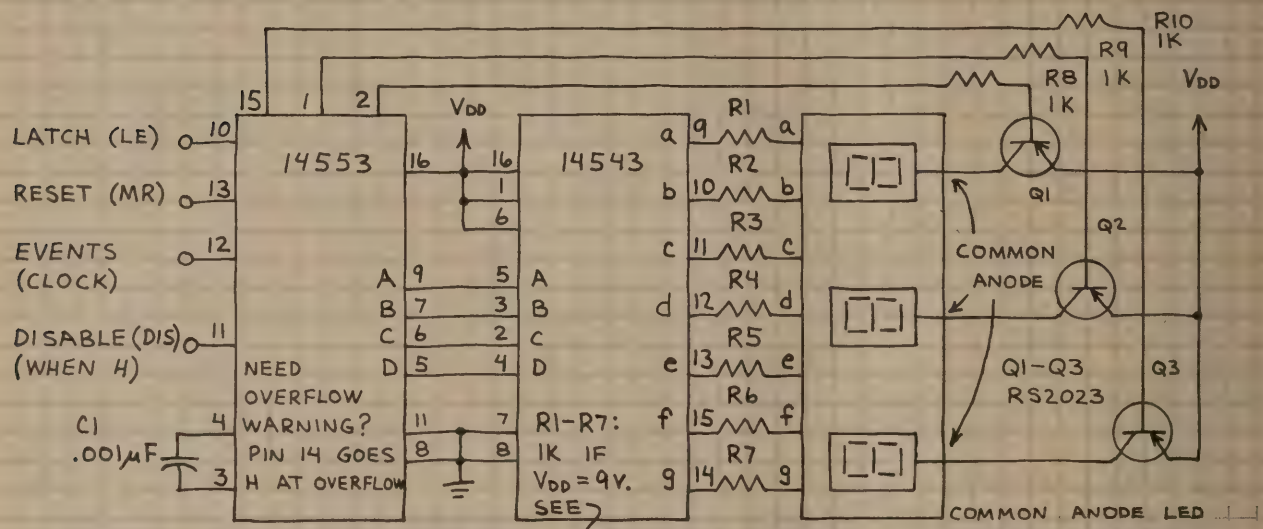


3-DIGIT BCD COUNTER MC14553

COMPLETE 3-DIGIT COUNTER. USE FOR DO-IT-YOURSELF EVENT AND FREQUENCY COUNTERS. BEGINNERS: GET SOME PRACTICAL CIRCUIT EXPERIENCE BEFORE USING THIS CHIP. PIN EXPLANATIONS: DS (DIGIT SELECT) 1, 2, 3 — SEQUENTIALLY STROBES READOUTS. LE — LATCH ENABLE (WHEN H). DIS — INHIBITS INPUT WHEN H. CLOCK — INPUT. MR — MASTER RESET (WHEN H). OF — OVERFLOW. A, B, C, D — BCD OUTPUTS.


VDD (+3-18 V)
CLOCK
DS3 OF MR
DIS LE A
16 15 14 13 12 11 10 9
SEE RADIO SHACK DATA BOOK FOR MORE INFORMATION...
1 2 3 4 5 6 7 8
DS2 DS1
D C B
.001 μF
(FOR DIGIT SELECT OSCILLATOR)

3-DIGIT EVENT COUNTER

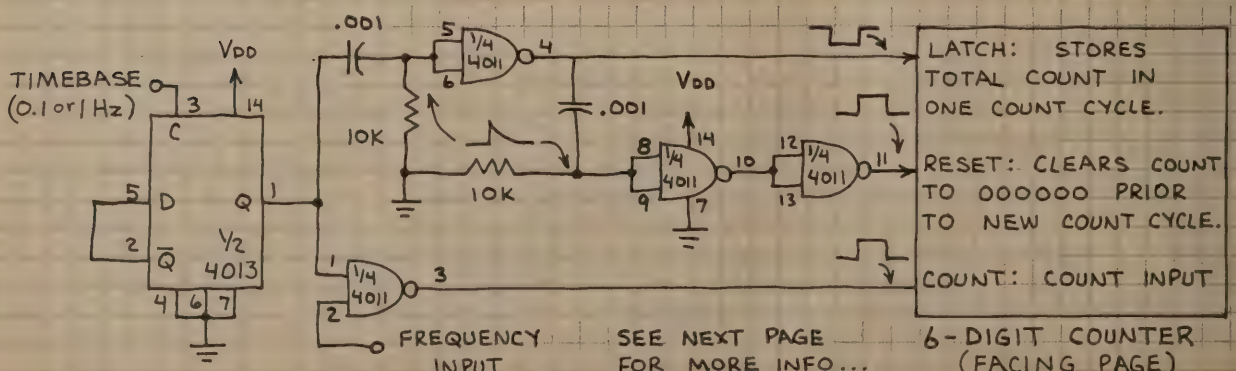


OK TO USE LIQUID CRYSTAL DISPLAY OR COMMON CATHODE LED DISPLAY. SEE 14543 FOR DETAILS.

SELECT R1-R7 SO LED CURRENT DOES NOT EXCEED 10 mA.

COMMON ANODE LED DISPLAYS. USE MULTI-DIGIT DISPLAY OR WIRE TOGETHER MATCHING CATHODES OF 3 DISPLAYS.

6-DIGIT FREQUENCY COUNTER



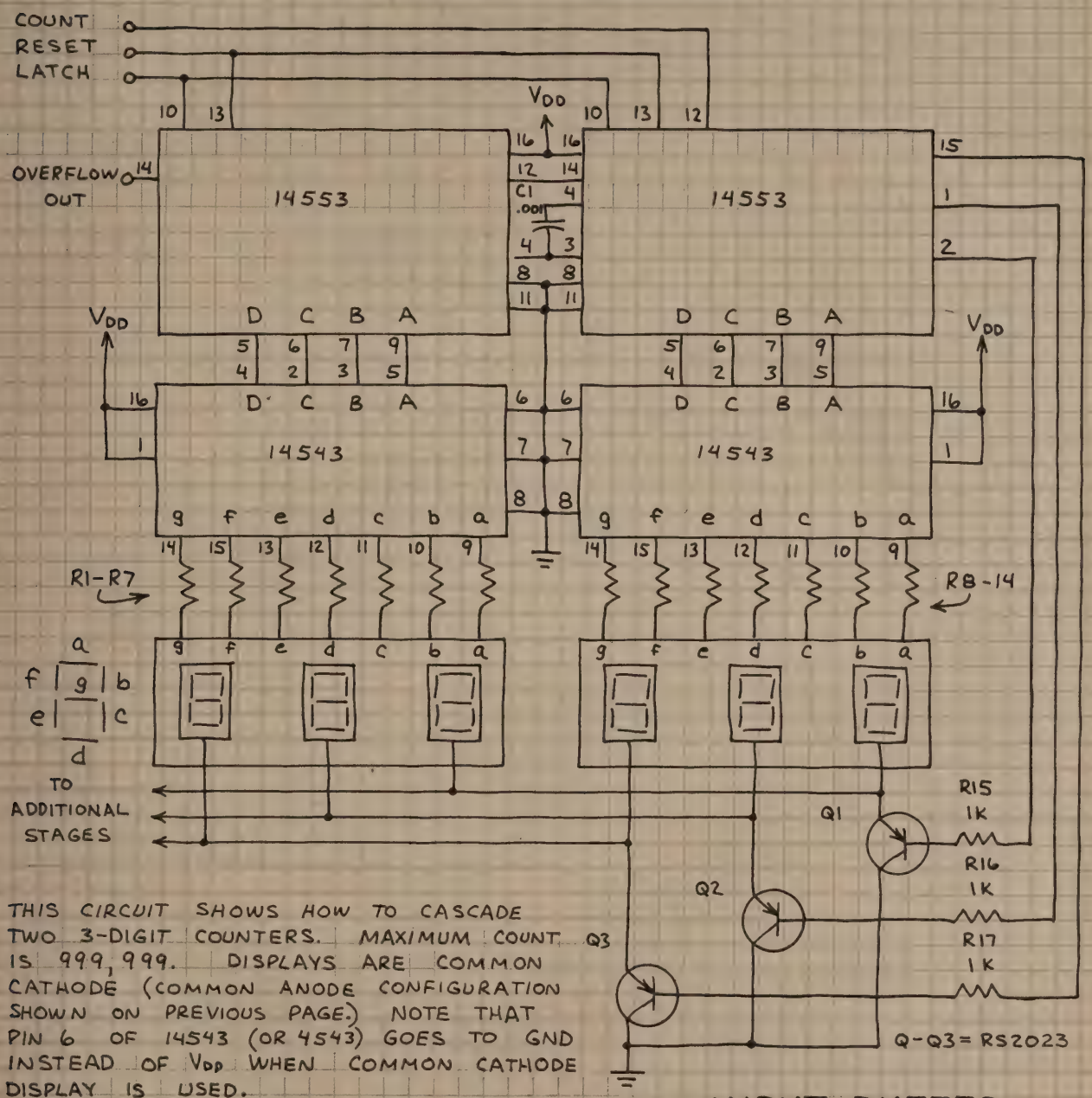
FREQUENCY INPUT

SEE NEXT PAGE FOR MORE INFO...

6-DIGIT COUNTER (FACING PAGE)

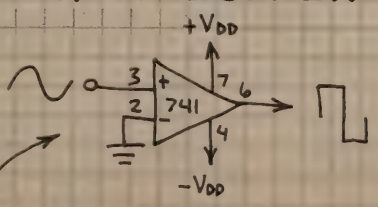
3-DIGIT BCD COUNTER (CONTINUED)
MC14553

6-DIGIT COUNTER



THIS CIRCUIT SHOWS HOW TO CASCADE TWO 3-DIGIT COUNTERS. MAXIMUM COUNT IS 999,999. DISPLAYS ARE COMMON CATHODE (COMMON ANODE CONFIGURATION SHOWN ON PREVIOUS PAGE.) NOTE THAT PIN 6 OF 14543 (OR 4543) GOES TO GND INSTEAD OF V_{DD} WHEN COMMON CATHODE DISPLAY IS USED.

INPUT BUFFER

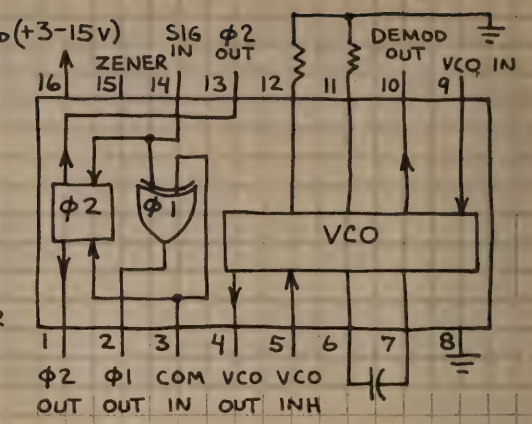


FREQUENCY COUNTER:

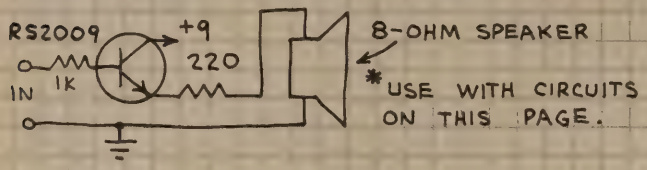
USE INPUT AND CONTROL CIRCUIT ON PREVIOUS PAGE. INPUT FREQUENCY SHOULD NOT EXCEED V_{DD}. NON-SQUARE WAVE INPUTS MAY REQUIRE INPUT TAILORING. USE COMPARATOR TO SHARPEN SLOW RISING WAVES.

PHASE-LOCKED LOOP (PLL)
4046

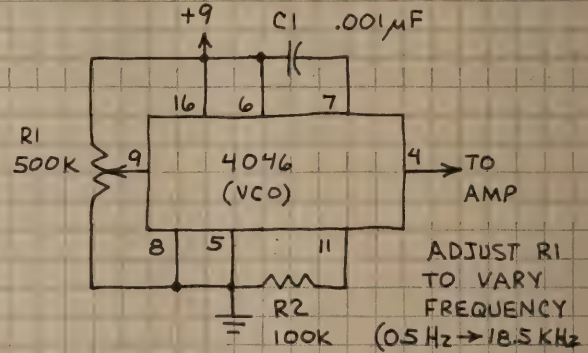
EXCEPTIONALLY VERSATILE CHIP. CONTAINS TWO PHASE COMPARATORS AND VOLTAGE CONTROLLED OSCILLATOR (VCO). USE VCO AND ONE PHASE COMPARATOR TO MAKE PLL. CIRCUITS ON THIS PAGE USE VCO ONLY. SEE RADIO SHACK SEMICONDUCTOR REFERENCE HANDBOOK FOR MORE INFORMATION.



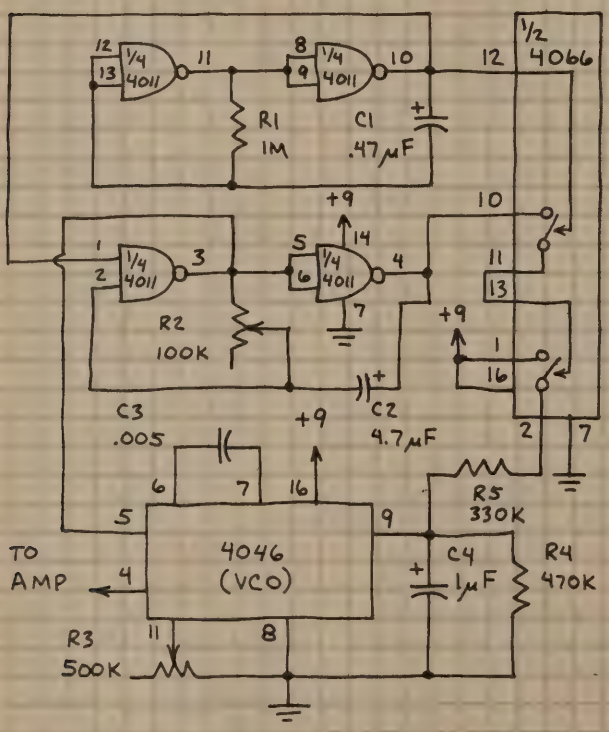
SPEAKER AMPLIFIER*



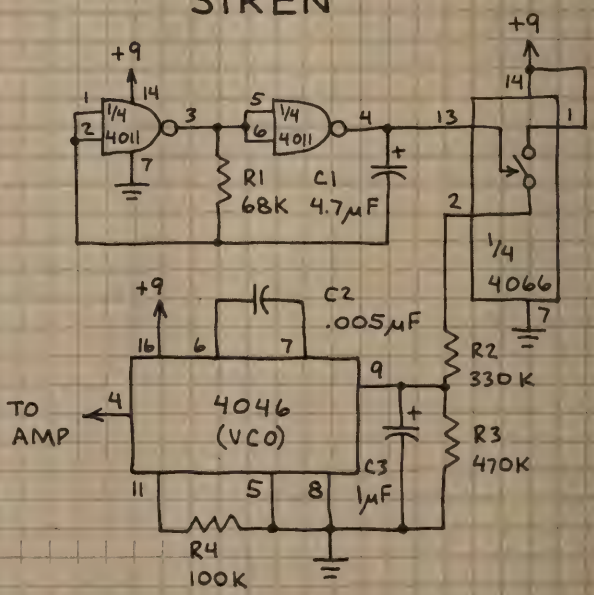
TUNABLE OSCILLATOR



CHIRP BURST SEQUENCER



SIREN



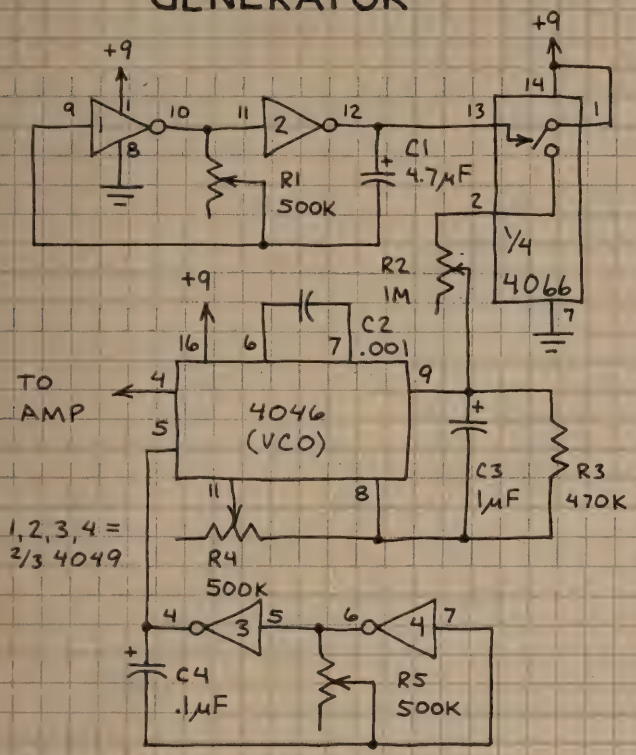
R2: ADJUST FOR 1-4 CHIRPS PER CYCLE. CHIRPS WILL HAVE DIFFERENT FREQUENCIES.

R3: CONTROLS PITCH OF CHIRPS. FOR TONES INSTEAD OF CHIRPS, CONNECT TO PIN 12 INSTEAD OF PIN 11.

CHANGE R1 OR C1 TO ALTER CYCLE TIME.
CHANGE R4 OR C2 TO ALTER FREQUENCY.
CHANGE R3 OR C3 TO ALTER WAIL.

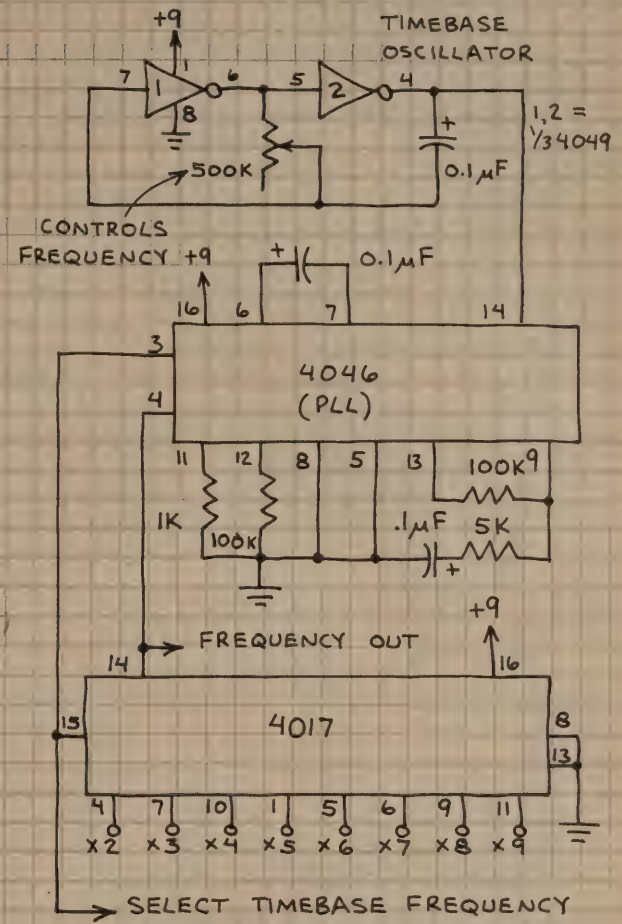
PHASE LOCKED LOOP (CONTINUED)
4046

SOUND EFFECTS GENERATOR



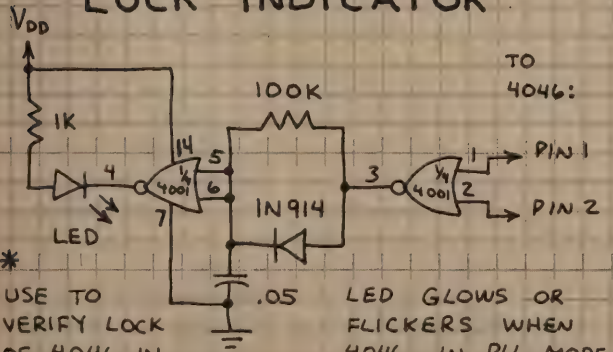
PRODUCES FASCINATING VARIETY OF UNDULATING AND CHOPPED TONES. R1 CONTROLS CYCLE TIME. R2 CONTROLS DELAY TIME. R4 CONTROLS FREQUENCY RANGE. R5 CONTROLS CHOPPING RATE. CHANGING R5's SETTING GIVES MOST DRAMATIC RESULTS.

FREQUENCY SYNTHESIZER



SELECT TIMEBASE FREQUENCY MULTIPLICATION FACTOR. SET TIMEBASE TO ~100Hz.

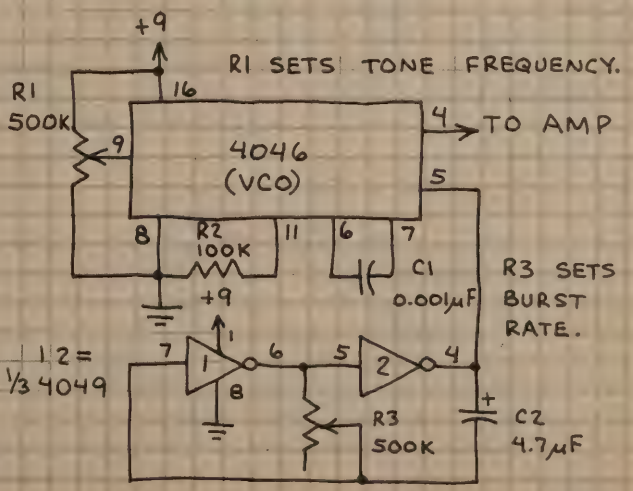
LOCK INDICATOR *



* USE TO VERIFY LOCK OF 4046 IN PLL MODE.

LED GLOWS OR FLICKERS WHEN 4046 IN PLL MODE IS OUT OF LOCK.

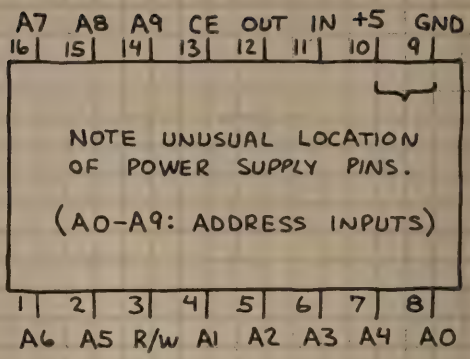
TONE BURST GENERATOR



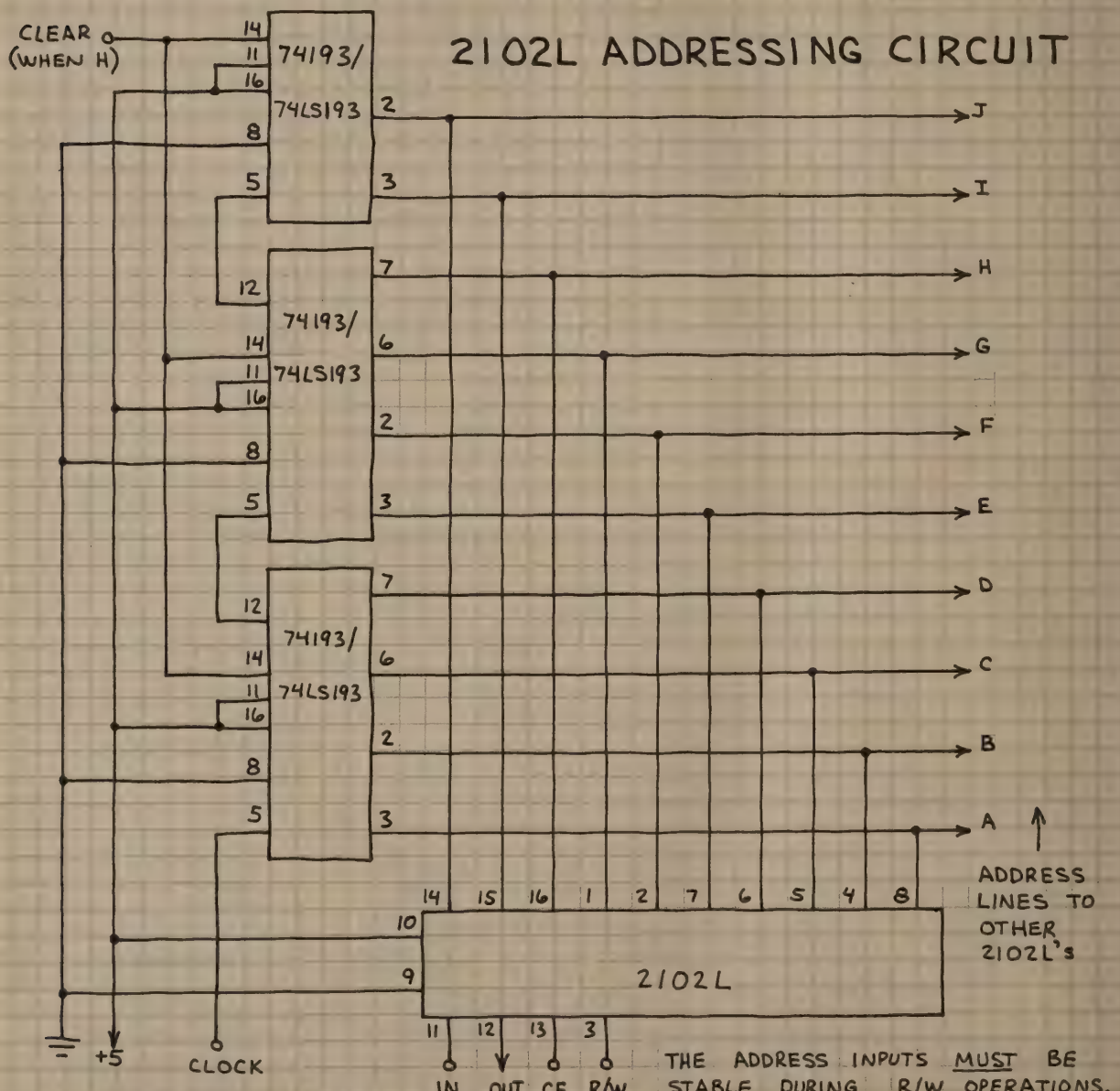
1024-BIT STATIC RAM
2102L

1024 1-BIT STORAGE LOCATIONS ADDRESSED BY PINS A0-A9. TTL/LS COMPATIBLE. CE (CHIP ENABLE) INPUT CONTROLS R/W (READ/WRITE) OPERATIONS). 3-STATE OUTPUTS.

CE	R/W	OPERATION
L	L	WRITE (LOADS BIT AT PIN 11)
L	H	READ (OUTPUTS BIT AT PIN 12)
H	X	HI Z (OUTPUT ENTERS THIRD STATE)


A7 A8 A9 CE OUT IN +5 GND
16 15 14 13 12 11 10 9
NOTE UNUSUAL LOCATION OF POWER SUPPLY PINS.
(A0-A9: ADDRESS INPUTS)
1 2 3 4 5 6 7 8
A6 A5 R/W A1 A2 A3 A4 A0

2102L ADDRESSING CIRCUIT

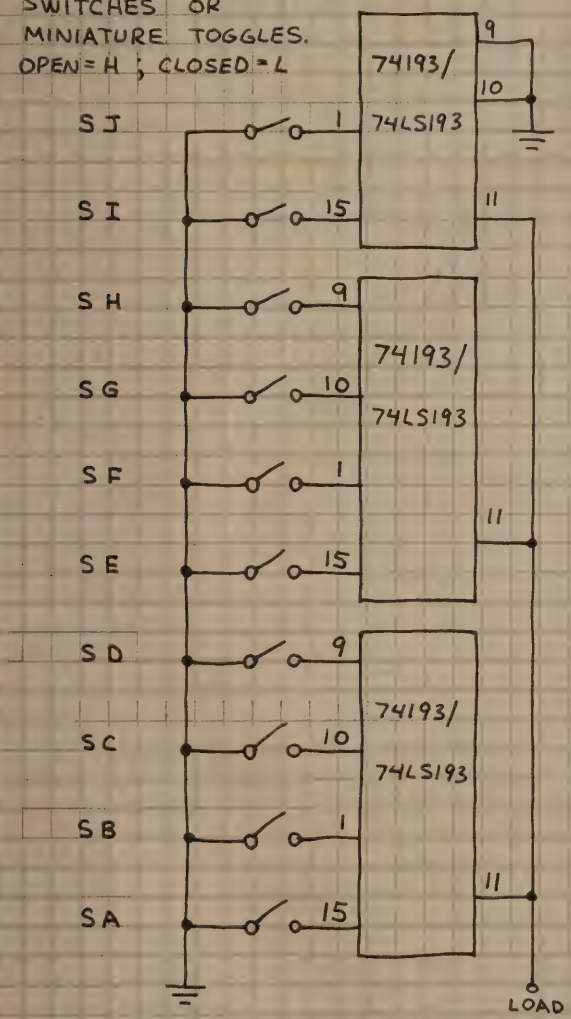


1024-BIT STATIC RAM (CONTINUED)
2102L

ADDING PROGRAMMED OR MANUAL JUMP

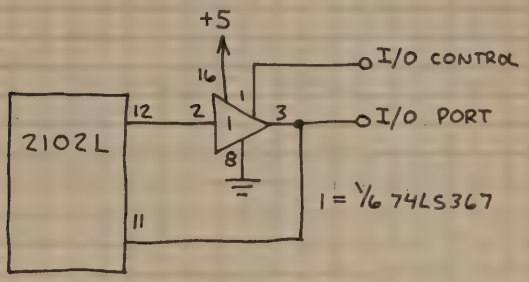
ADD THESE CONNECTIONS TO THE ADDRESSING CIRCUIT ON FACING PAGE.

SA-SJ: USE 8-POSITION DIP SWITCHES OR MINIATURE TOGGLES. OPEN = H ; CLOSED = L



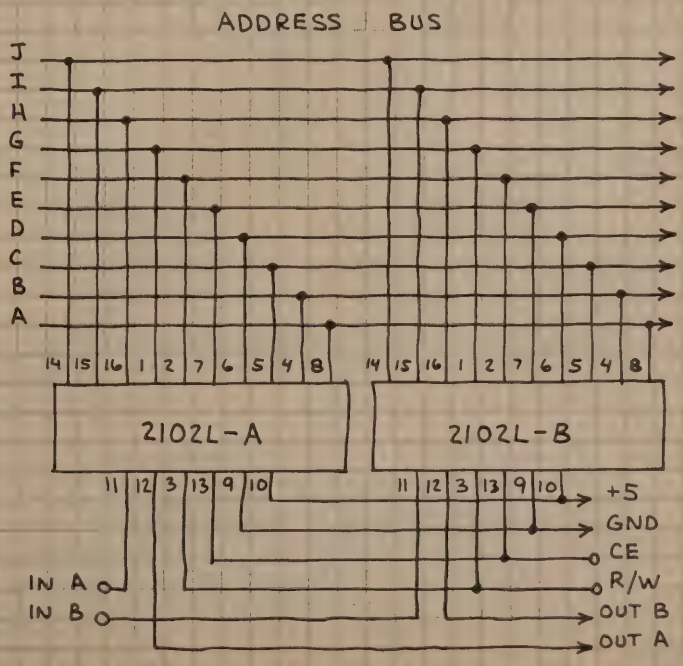
NORMALLY THE LOAD INPUT IS HIGH. MAKING LOAD LOW LOADS THE ADDRESS PROGRAMMED IN SWITCHES SA-SJ INTO THE 74193's. THIS PERMITS A PROGRAMMED JUMP OR A MANUAL JUMP TO ANY ADDRESS.

SINGLE I/O PORT



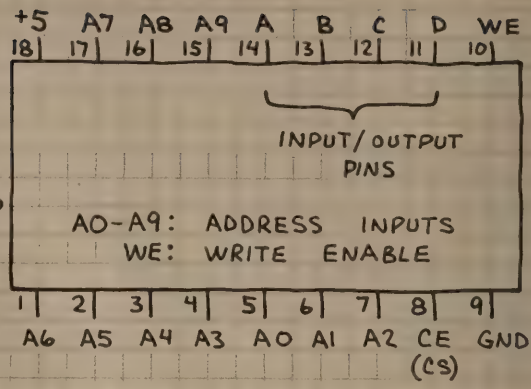
ADD THIS CIRCUIT TO THE ADDRESSING CIRCUIT ON FACING PAGE. WHEN I/O (INPUT/OUTPUT) CONTROL IS H, PIN 3 OF THE 74LS367 ENTERS THIRD STATE (HI-Z) AND I/O PORT ACCEPTS INPUT DATA. WHEN PIN 3 OF THE 74LS367 IS L, I/O PORT OUTPUTS DATA. BOTH THESE OPERATIONS ARE DEPENDENT UPON THE STATUS OF THE 2102L CONTROL INPUTS.

CASCADING 2102L'S

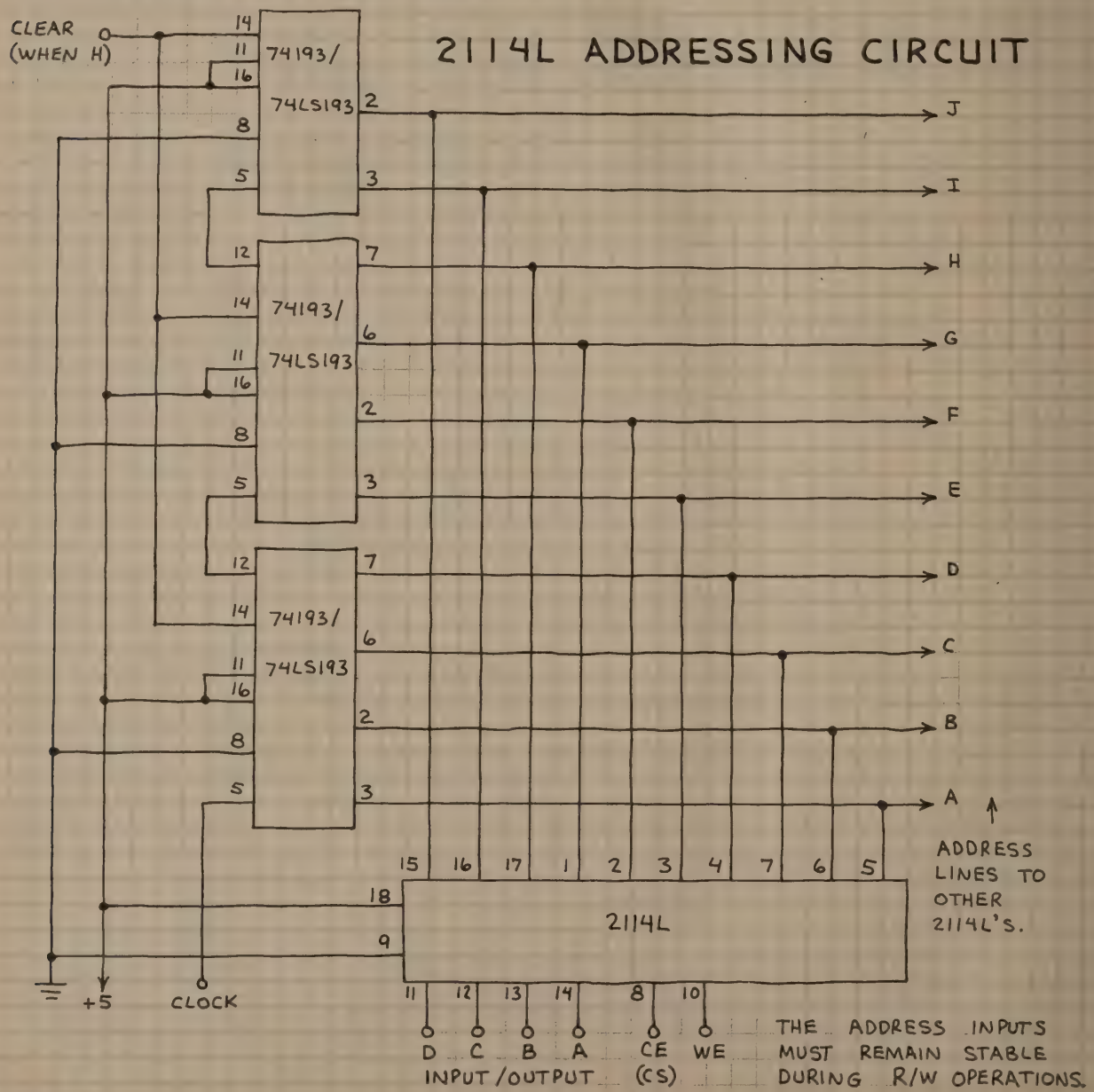


1024 x 4-BIT RAM
2114L/4045

1024-4-BIT STORAGE LOCATIONS ADDRESSED BY PINS A0-A9. TTL/LS COMPATIBLE. FOR READ/WRITE OPERATIONS, CE (CHIP ENABLE, ALSO CALLED CHIP SELECT) MUST BE LOW. WE INPUT MUST BE LOW TO WRITE (LOAD) DATA INTO CHIP. WHEN WE IS HIGH, DATA IN ADDRESSED LOCATION APPEARS AT INPUT/OUTPUT PINS. IDEAL CHIP FOR DO-IT-YOURSELF MICROCOMPUTERS AND CONTROLLERS.


+5 A7 A8 A9 A B C D WE
18 17 16 15 14 13 12 11 10
INPUT/OUTPUT PINS
A0-A9: ADDRESS INPUTS
WE: WRITE ENABLE
1 2 3 4 5 6 7 8 9
A6 A5 A4 A3 A0 A1 A2 CE (CS) GND

2114L ADDRESSING CIRCUIT

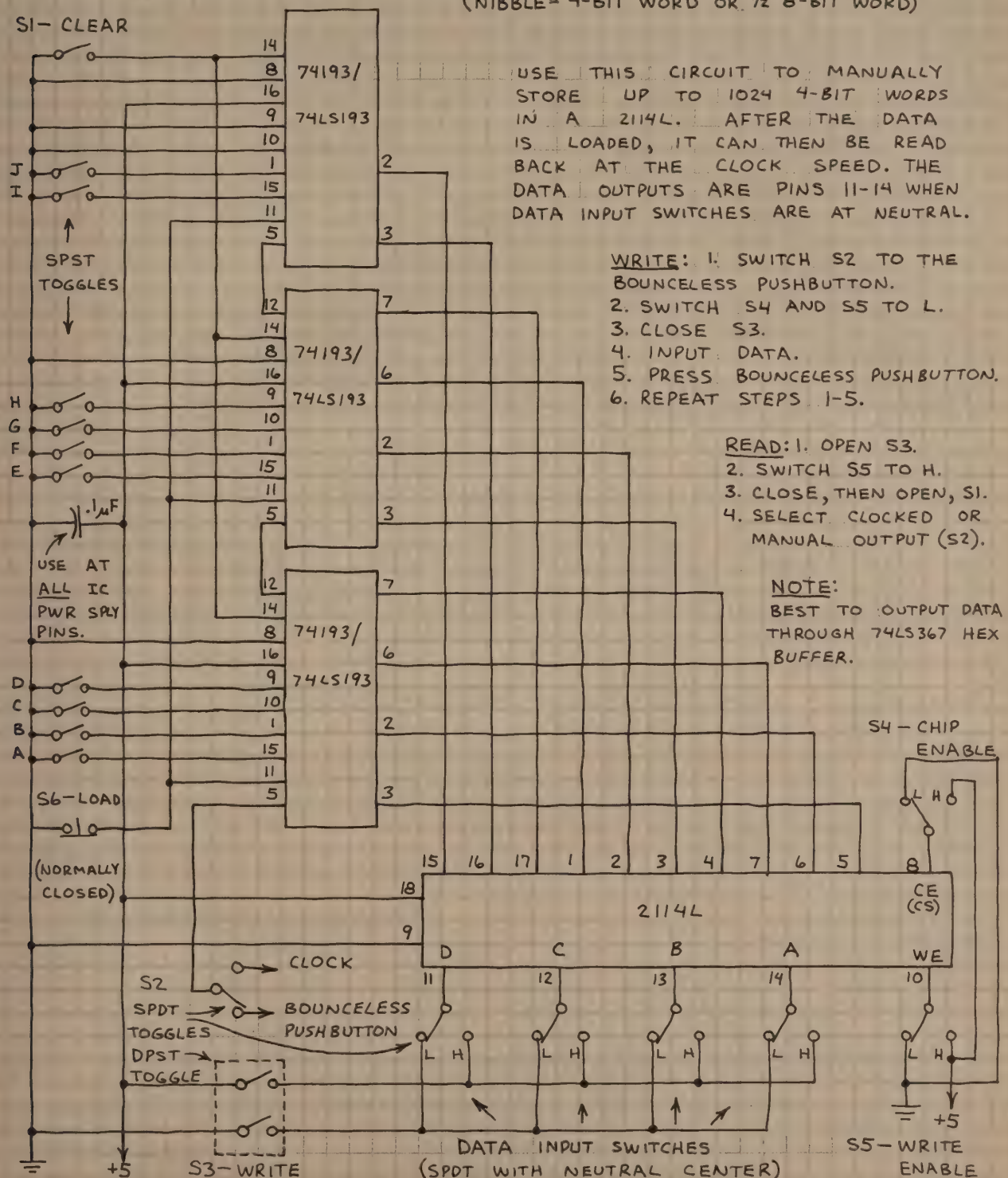


1024 x 4-BIT RAM (CONTINUED)
2114L/4045

1024-NIBBLE DATA LOADING CIRCUIT

(NIBBLE = 4-BIT WORD OR ½ 8-BIT WORD)

MANUAL JUMP: 1. SET SWITCHES A-J TO DESIRED ADDRESS; 2. PRESS S6.



USE THIS CIRCUIT TO MANUALLY STORE UP TO 1024 4-BIT WORDS IN A 2114L. AFTER THE DATA IS LOADED, IT CAN THEN BE READ BACK AT THE CLOCK SPEED. THE DATA OUTPUTS ARE PINS 11-14 WHEN DATA INPUT SWITCHES ARE AT NEUTRAL.

WRITE: 1. SWITCH S2 TO THE BOUNCELESS PUSHBUTTON.
2. SWITCH S4 AND S5 TO L.
3. CLOSE S3.
4. INPUT DATA.
5. PRESS BOUNCELESS PUSHBUTTON.
6. REPEAT STEPS 1-5.

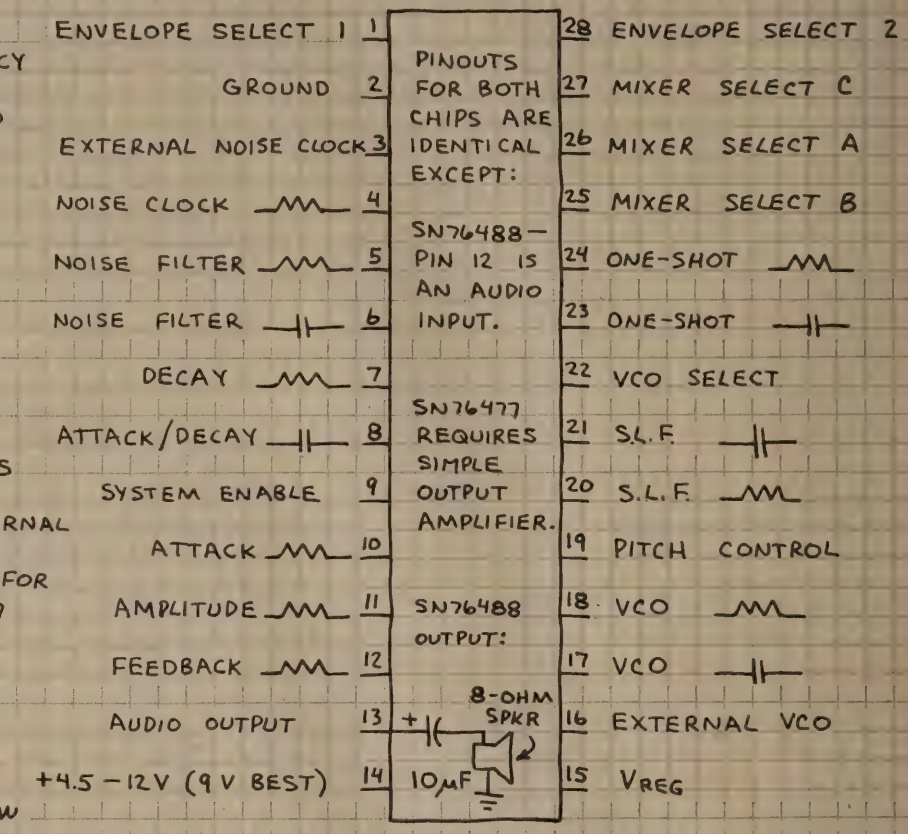
READ: 1. OPEN S3.
2. SWITCH S5 TO H.
3. CLOSE, THEN OPEN, S1.
4. SELECT CLOCKED OR MANUAL OUTPUT (S2).

NOTE:
BEST TO OUTPUT DATA THROUGH 74LS367 HEX BUFFER.

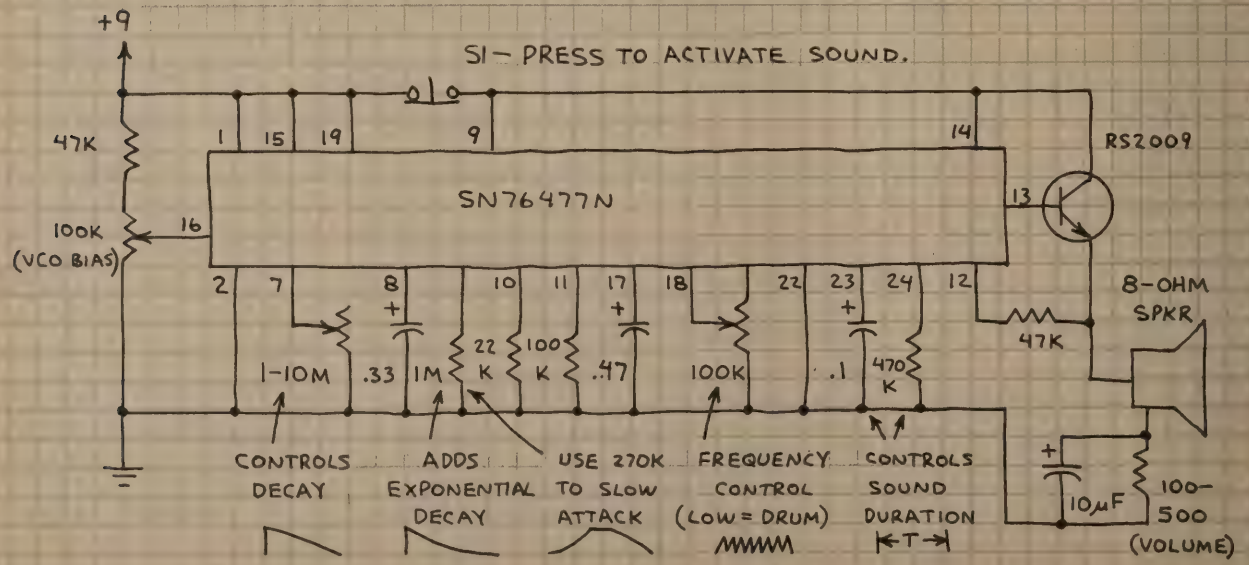
COMPLEX SOUND GENERATOR
SN76477N / SN76488N

NOTE: THE SN76488 INCLUDES BUILT-IN SPEAKER AMPLIFIER. THE SN76477 DOES NOT.

INCORPORATES S.L.F. (SUPER LOW FREQUENCY OSCILLATOR), VCO (VOLTAGE CONTROLLED OSCILLATOR), NOISE GENERATOR AND A MIXER THAT ALLOWS THE OUTPUTS FROM ONE OR MORE OF THE ABOVE TO BE COMBINED. CAN BE OPERATED TOGETHER WITH APPROPRIATE RESISTORS AND CAPACITORS TO PRODUCE MANY KINDS OF SOUNDS. CAN BE CONTROLLED BY EXTERNAL LOGIC. SEE DATA SUPPLIED WITH CHIP FOR MORE INFO. SN76477 AND SN76488 ARE INTERCHANGEABLE... BUT SN76488 DOES NOT NEED OUTPUT AMPLIFIER. NOTE: THIS CHIP IS EASY TO USE IF YOU FOLLOW DATA SHEET INSTRUCTIONS.

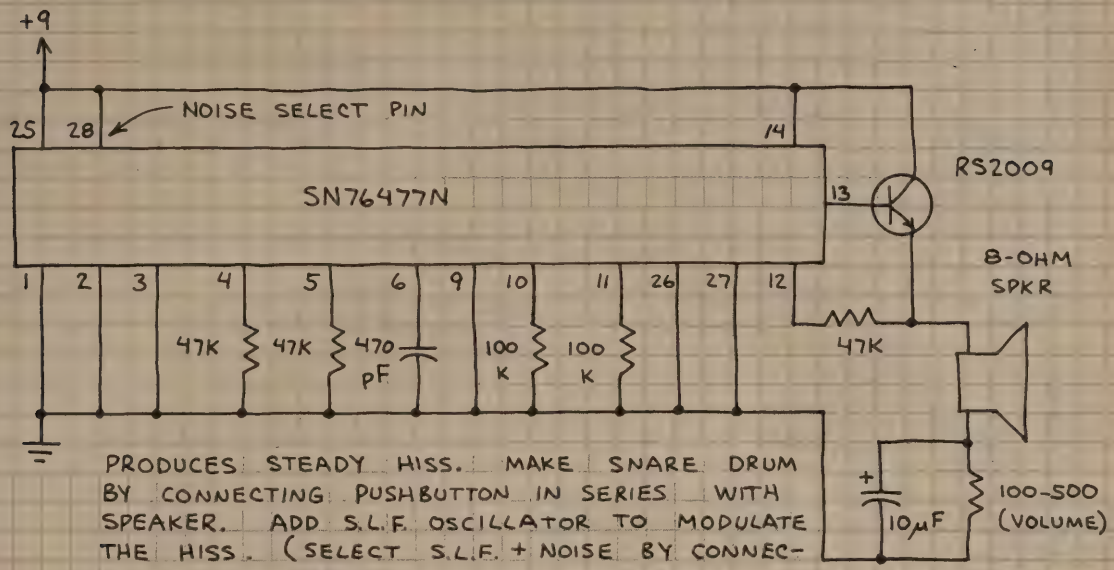


PERCUSSION SYNTHESIZER



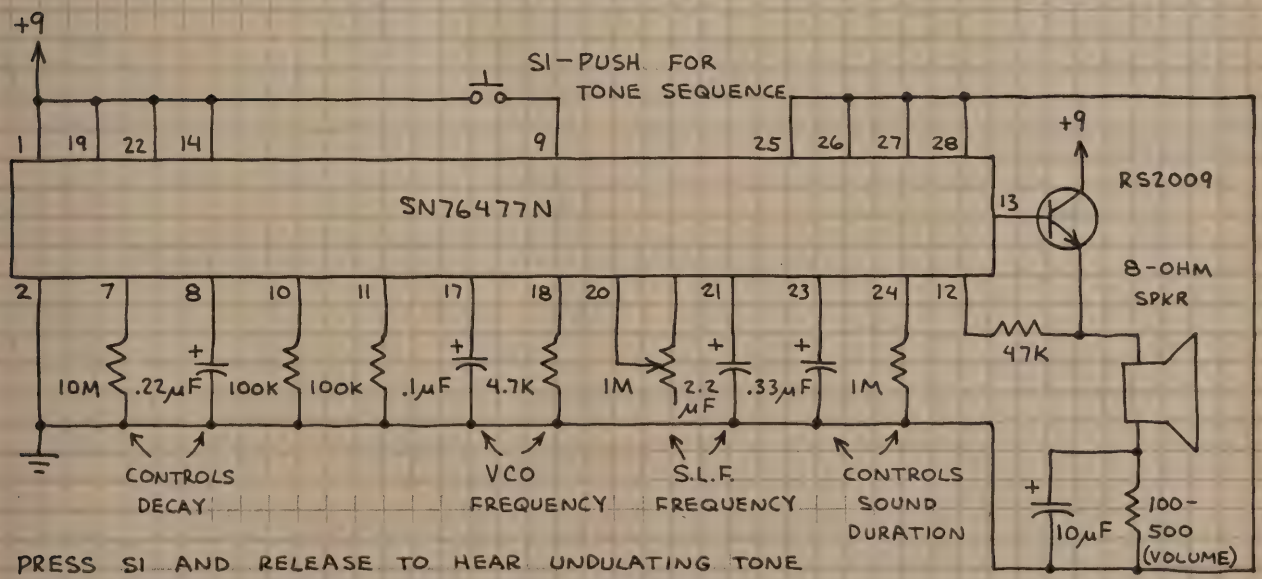
COMPLEX SOUND GENERATOR (CONTINUED)
SN76477N / SN76488N

NOISE GENERATOR



PRODUCES STEADY HISS. MAKE SNARE DRUM BY CONNECTING PUSHBUTTON IN SERIES WITH SPEAKER. ADD S.L.F. OSCILLATOR TO MODULATE THE HISS. (SELECT S.L.F. + NOISE BY CONNECTING PINS 25 AND 26 TO GND AND PIN 27 TO +9 V. ADD 1M POT FROM PIN 20 TO GND AND 1μF CAPACITOR FROM PIN 21 TO GND.) SOUNDS LIKE STEAM TRAIN OR PROPELLER AIRCRAFT DEPENDING ON ADJUSTMENT OF 1M POT.

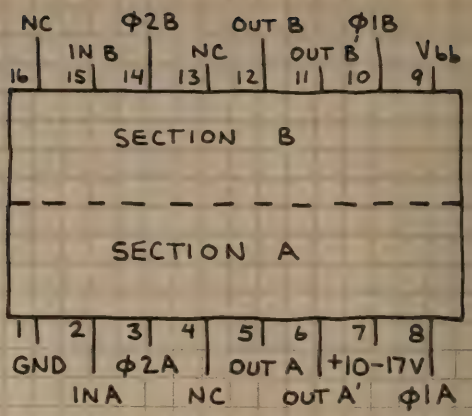
UNIVERSAL UP-DOWN TONE GENERATOR



PRESS S1 AND RELEASE TO HEAR UNDULATING TONE THAT GRADUALLY DECAYS AND STOPS. CHANGE VCO AND S.L.F. COMPONENTS FOR MANY DIFFERENT SOUND EFFECTS RANGING FROM SIREN TO SCIENCE FICTION MOVIE SOUNDS. FOR CONTINUOUS SOUND, OMIT COMPONENTS AT PINS 7, 8, 23, 24 AND GROUND PIN 9.

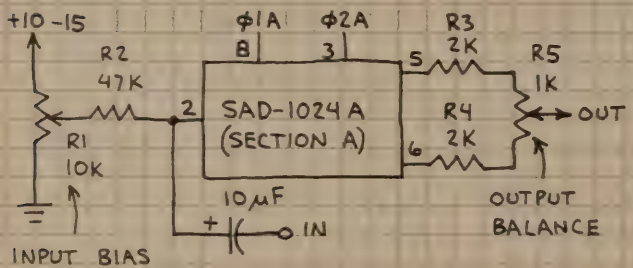
DUAL ANALOG DELAY LINE SAD-1024A

CONTAINS TWO INDEPENDENT 512 STAGE SERIAL ANALOG DELAY (SAD) LINES (ALSO CALLED ANALOG SHIFT REGISTERS). OK TO USE EACH 512 STAGE SAD SEPARATELY OR IN SERIES. ANALOG DELAYS OF UP TO ½ SECOND CAN BE ACHIEVED. A 2-PHASE CLOCK IS REQUIRED TO DRIVE INPUTS Φ1 AND Φ2. INPUT DATA RIDES THROUGH THE SAD ON ALTERNATING CLOCK PULSES AND APPEAR AT THE TWO OUTPUTS AFTER PASSING THROUGH ALL 512 STAGES. CONNECT V_{bb} TO V_{DD} (PIN 7) OR, FOR OPTIMUM RESULTS, TO 1 VOLT BELOW V_{DD}. THIS CHIP CAN BE TRICKY TO USE SINCE SEVERAL EXTERNAL ADJUSTMENTS ARE REQUIRED. CIRCUITS ON THIS PAGE EXPLAIN OPERATING REQUIREMENTS WHILE A COMPLETE CIRCUIT IS SHOWN ON FACING PAGE.

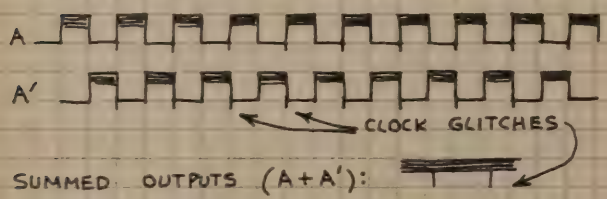


CAUTION: THIS NMOS CHIP IS VULNERABLE TO DAMAGE FROM STATIC DISCHARGE! FOLLOW CMOS HANDLING PROCEDURES.

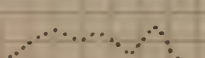
SAD IN/OUT CONTROLS



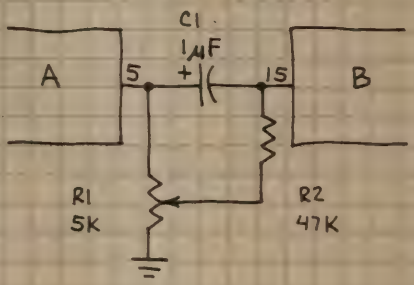
ADJUST R1 (INPUT BIAS) FOR OPTIMUM AUDIO OUTPUT. OUTPUTS APPEAR LIKE THIS ON A SCOPE:



SET SCOPE TO VISUALIZE INPUT SIGNAL (COMPRESSING CLOCK RATE):

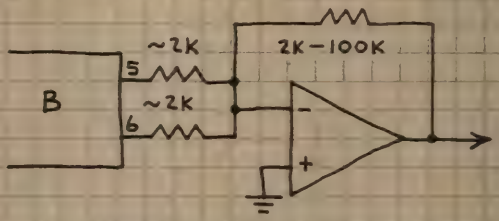


SERIAL OPERATION



R1 CONTROLS BIAS TO SECTION B. NOTE THAT ONLY ONE OUTPUT OF A IS CONNECTED TO INPUT OF B.

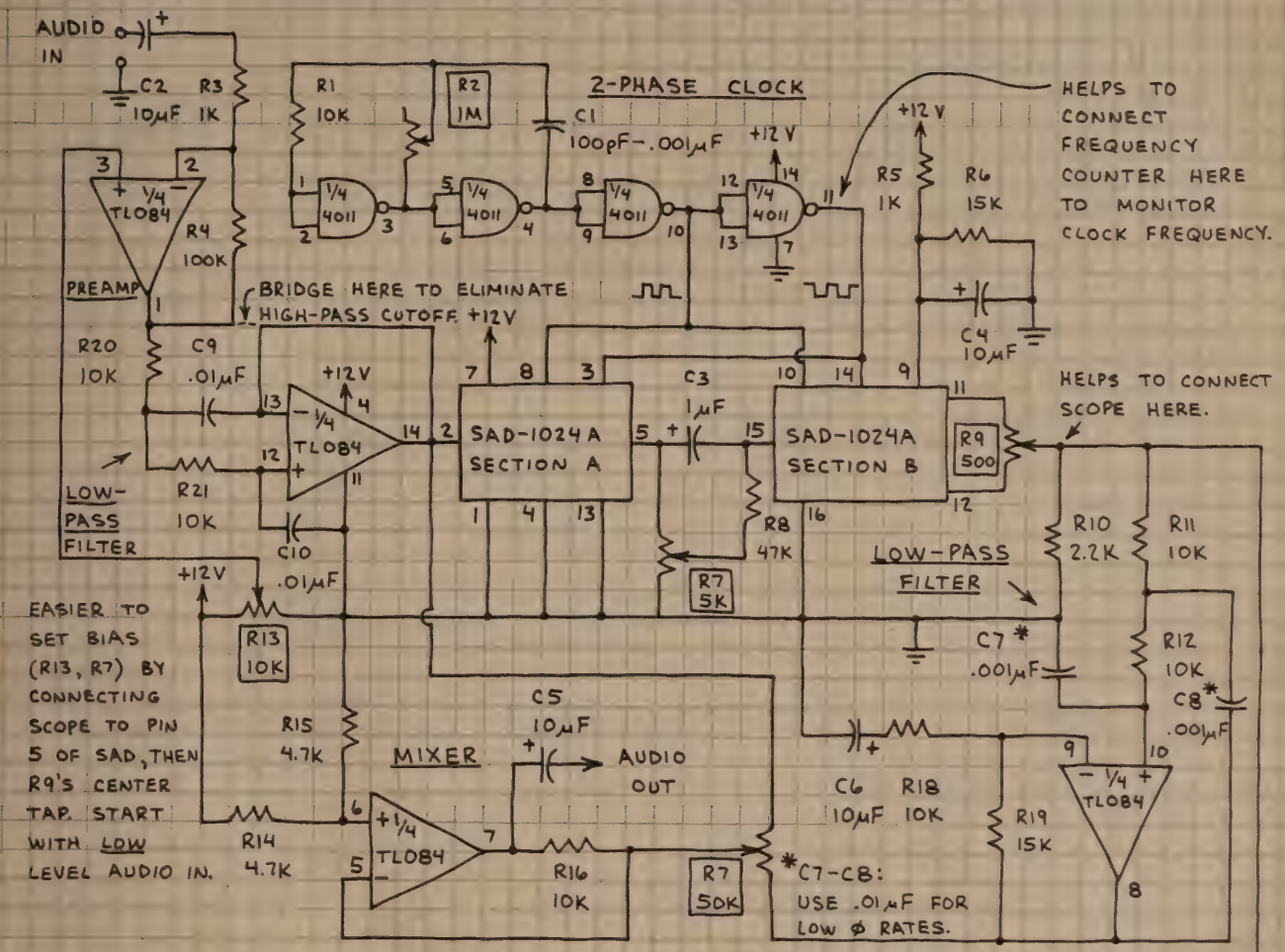
OUTPUT SUMMER



ANY OP-AMP CAN BE USED, BUT LOW NOISE FET INPUT TYPES ARE BEST.

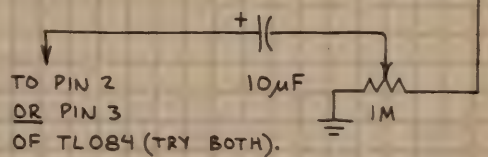
DUAL ANALOG DELAY LINE (CONTINUED)
SAD-1024A

ADJUSTABLE FLANGER OR PHASER



ADJUST CIRCUIT FOR DESIRED EFFECT BY CONNECTING TRANSISTOR RADIO TO AUDIO INPUT. TUNE RADIO TO A TALK SHOW FOR BEST RESULTS. R13 AND R7 CONTROL BIAS TO SECTIONS A AND B OF THE SAD. R9 BALANCES THE SAD OUTPUTS. R2 CONTROLS THE CLOCK RATE. R17 IS THE MAIN BALANCE CONTROL. IT CONTROLS THE RELATIVE AMPLITUDES OF THE ORIGINAL AND DELAYED SIGNAL APPLIED TO THE MIXER. CONNECT THE OUTPUT TO A POWER AMPLIFIER. YOU MUST ADJUST BIAS CONTROLS PROPERLY FOR BEST RESULTS. SET R2 FOR LOW FREQUENCIES (3-8KHz) FOR SINGLE ECHO. USE HIGHER CLOCK FREQUENCIES (20-100 KHz) FOR HOLLOW, SWISHY SOUNDS. NOTE: THIS CIRCUIT IS NOT FOR BEGINNERS.

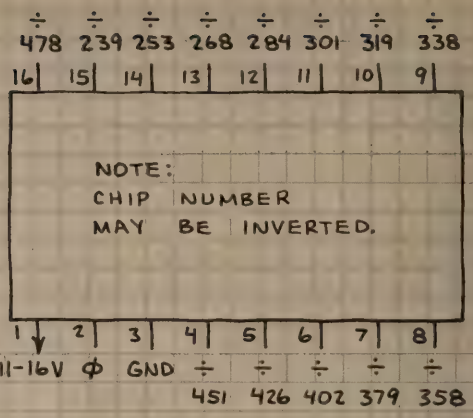
REVERBERATOR



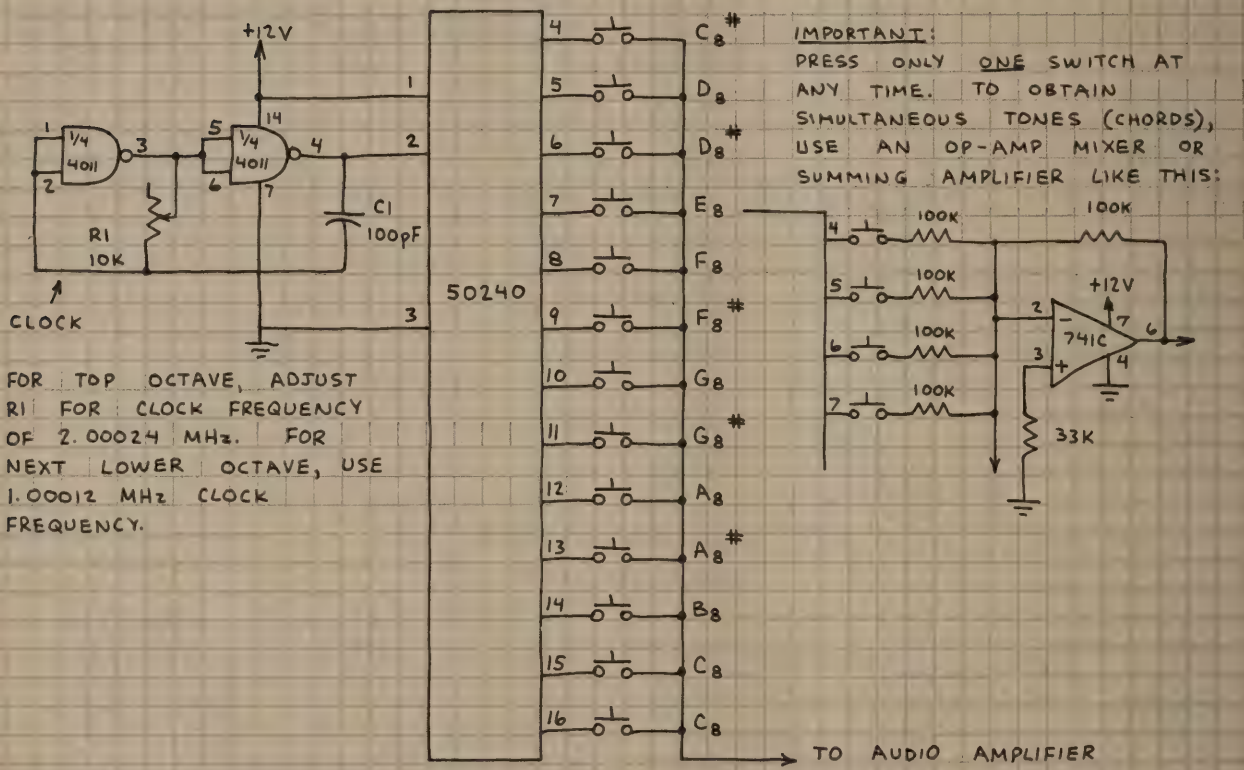
ADD THIS FEEDBACK CIRCUIT FOR UNUSUAL REVERBERATION EFFECTS. SLOW CLOCK FREQUENCIES GIVE MOST STRIKING REVERBERATIONS. TRY 5-20 KHz. FASTER CLOCK (20-100 KHz) AND CAREFUL ADJUSTMENT GIVES ROBOT-LIKE SOUND USED IN SOME SCIENCE FICTION MOVIES.

TOP OCTAVE SYNTHESIZER S50240

THIS PMOS CHIP ACCEPTS AN INPUT FREQUENCY (Φ) AND THEN DIVIDES IT INTO A FULL OCTAVE PLUS ONE NOTE ON THE EQUALLY TEMPERED SCALE. THIS CHIP IS IDEAL FOR MUSIC SYNTHESIZERS, ORGANS, ETC. FOR TOP OCTAVE OPERATION, Φ SHOULD BE 2.00024 MHz; LOWER FREQUENCIES GIVE LOWER OCTAVES.



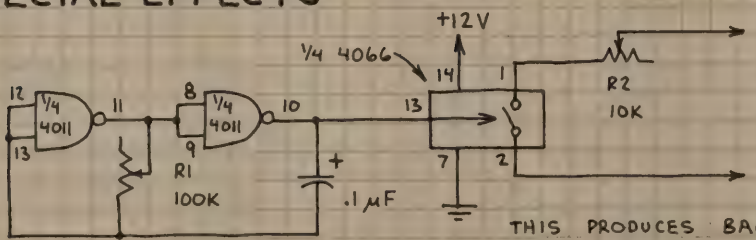
ADJUSTABLE OCTAVE SYNTHESIZER



FOR TOP OCTAVE, ADJUST R1 FOR CLOCK FREQUENCY OF 2.00024 MHz. FOR NEXT LOWER OCTAVE, USE 1.00012 MHz CLOCK FREQUENCY.

IMPORTANT: PRESS ONLY ONE SWITCH AT ANY TIME. TO OBTAIN SIMULTANEOUS TONES (CHORDS), USE AN OP-AMP MIXER OR SUMMING AMPLIFIER LIKE THIS:

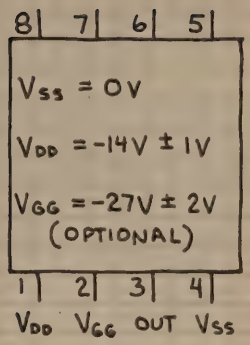
SPECIAL EFFECTS



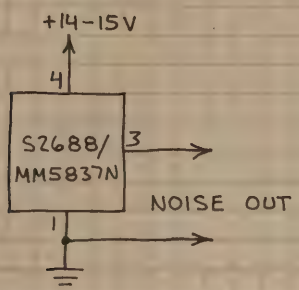
THIS PRODUCES BAGPIPE AND OTHER UNUSUAL SOUNDS. ADJUST R1 TO VARY INTERRUPTION RATE.

NOISE GENERATOR
S2688 / MM5837N

PRODUCES BROADBAND WHITE NOISE FOR AUDIO AND OTHER APPLICATIONS. THE NOISE QUALITY IS VERY UNIFORM. IT IS PRODUCED BY A 17-BIT SHIFT REGISTER WHICH IS CLOCKED BY AN INTERNAL OSCILLATOR.

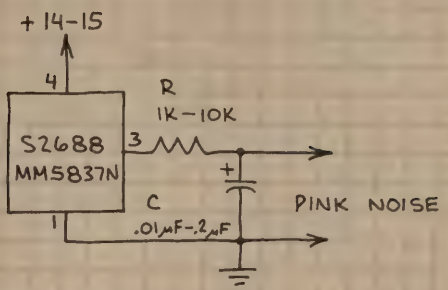


WHITE NOISE SOURCE



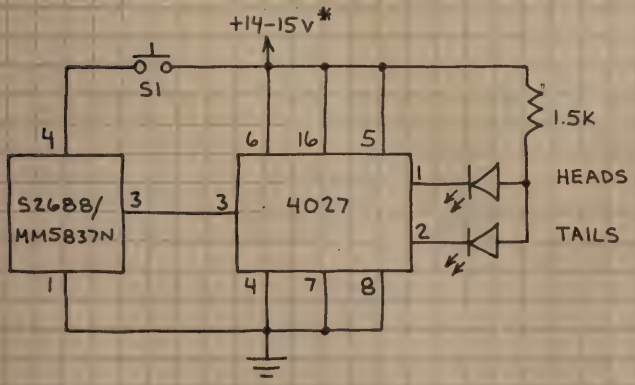
CONNECT OUTPUT TO AUDIO AMPLIFIER TO HEAR NOISE. USE 7815 VOLTAGE REGULATOR TO OBTAIN +15 VOLTS.

PINK NOISE SOURCE



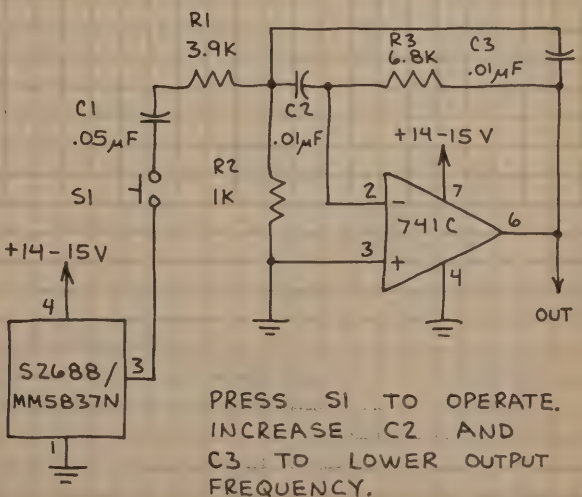
CHANGE R AND C TO ALTER NOISE SPECTRUM. ALSO, TRY LOWER SUPPLY VOLTAGES TO CHANGE SPECTRUM.

COIN TOSSER



PRESS S1; BOTH LEDs GLOW. RELEASE S1 AND ONLY ONE GLOWS. GROUND INPUTS OF UNUSED HALF OF 4027 (PINS 9, 10, 11, 12 AND 13).*(OK TO USE 9-VOLT BATTERY AS POWER SUPPLY.)

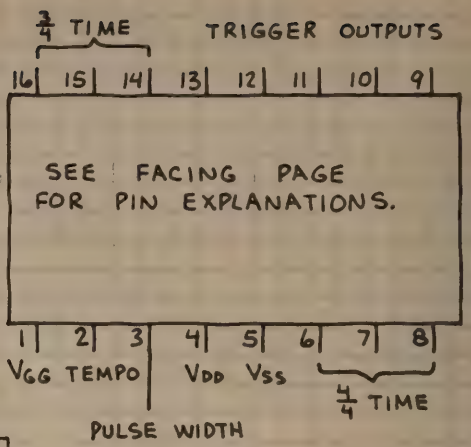
SNARE/BRUSH NOISE



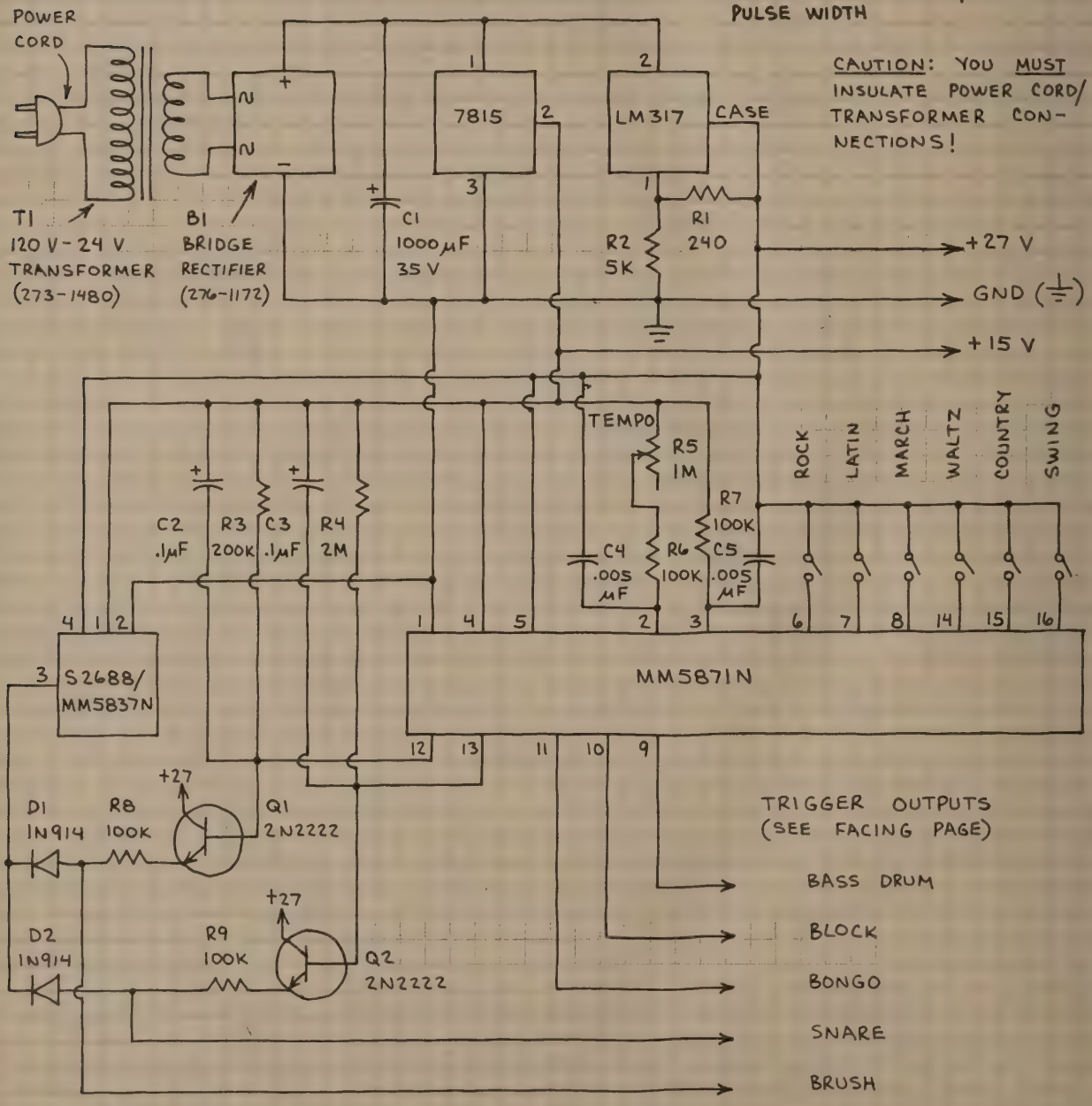
PRESS S1 TO OPERATE. INCREASE C2 AND C3 TO LOWER OUTPUT FREQUENCY.

RHYTHM PATTERN GENERATOR
MM5871

PRODUCES SIX DIFFERENT RHYTHM PATTERNS AND TRIGGERS FIVE DIFFERENT INSTRUMENTS. ADJUSTABLE TEMPO. COMPLICATED TO USE, BUT WELL WORTH THE EFFORT.



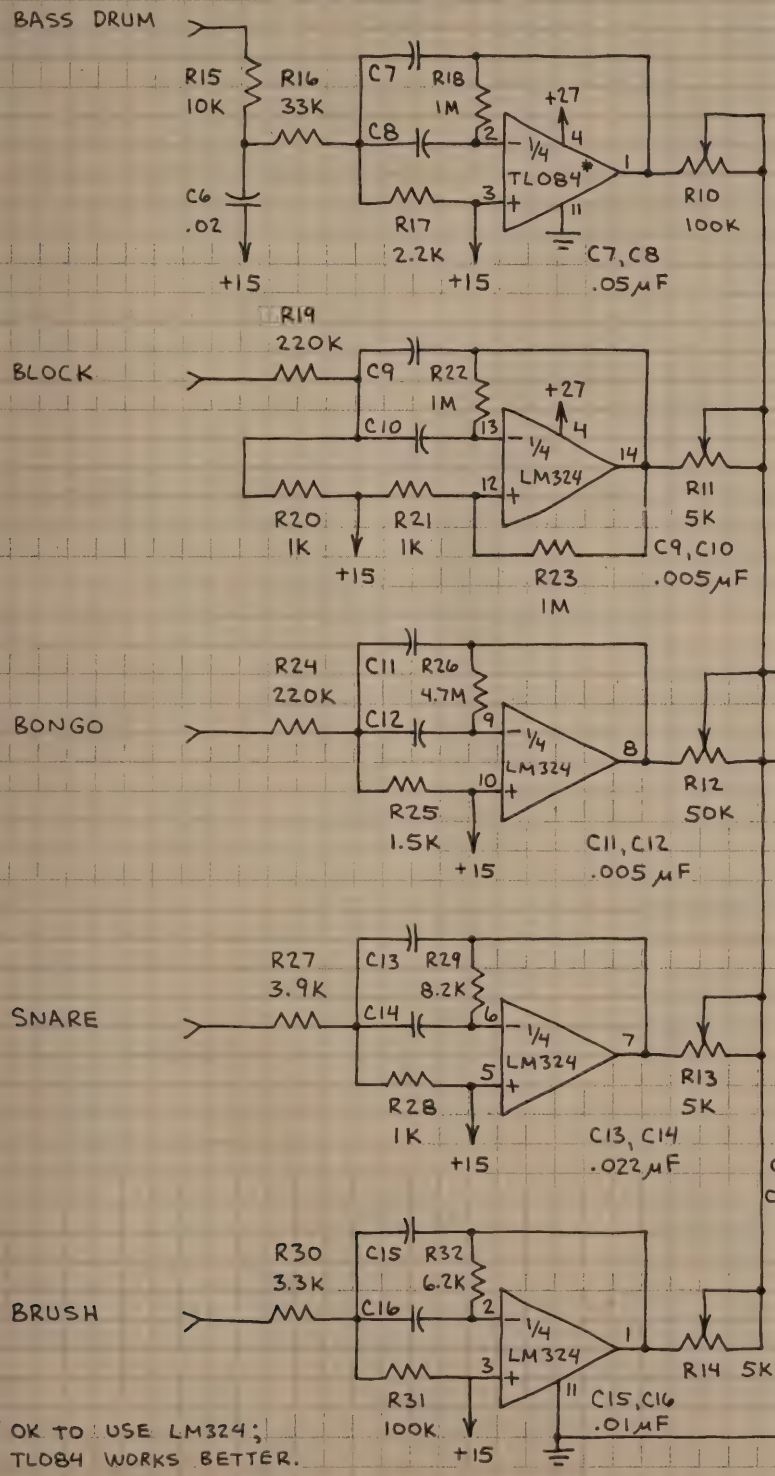
RHYTHM BOX



RHYTHM PATTERN GENERATOR (CONTINUED)
MM5871

PERCUSSION SYNTHESIZERS:

OK TO TUNE BY MAKING SLIGHT CHANGES TO RC COMPONENTS.



* OK TO USE LM324; TL084 WORKS BETTER.

MM5871 PIN EXPLANATIONS:

1 – V_{GG} (-27 V ± 2 V)
2 – TEMPO CONTROL (RC NETWORK)
3 – TRIGGER OUTPUT PULSE WIDTH CONTROL (RC NETWORK)
4 – V_{DD} (-14 V ± 2 V)
5 – V_{SS} (0 V)

PATTERN SELECT INPUTS –
6 – ROCK 8 – MARCH 15 – C/W
7 – LATIN 14 – WALTZ 16 – SWING

TRIGGER OUTPUTS –
9 – BASS 11 – BONGO 13 – SNARE
10 – BLOCK 12 – BRUSH

RHYTHM BOX OPERATION:

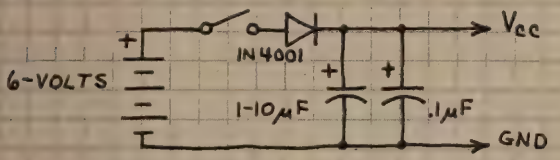
POTS R10–R14 CONTROL VOLUME OF EACH INSTRUMENT. EXPERIMENT WITH SETTINGS FOR BEST RESULTS. OK TO SELECT TWO OR MORE PATTERNS SIMULTANEOUSLY!

NOTES

TTL/LS INTEGRATED CIRCUITS

INTRODUCTION

TTL IS THE BEST ESTABLISHED AND MOST DIVERSIFIED IC FAMILY. LS IS FUNCTIONALLY IDENTICAL TO TTL BUT IS SLIGHTLY FASTER AND USES 80% LESS POWER. TTL/LS CHIPS REQUIRE A REGULATED 4.75–5.25 VOLT POWER SUPPLY. HERE'S A SIMPLE BATTERY SUPPLY:



THE DIODE DROPS THE BATTERY VOLTAGE TO A SAFE LEVEL. BOTH CAPACITORS SHOULD BE INSTALLED ON THE TTL/LS CIRCUIT BOARD. CIRCUITS WITH LOTS OF TTL/LS CHIPS CAN USE LOTS OF CURRENT. USE A COMMERCIAL 5 VOLT LINE POWERED SUPPLY TO SAVE BATTERIES. OR MAKE YOUR OWN. (SEE THE 7805 ON PAGE 94.)

OPERATING REQUIREMENTS

1. V_{cc} MUST NOT EXCEED 5.25 VOLTS.

2. INPUT SIGNALS MUST NEVER EXCEED V_{cc} AND SHOULD NOT FALL BELOW GND.

3. UNCONNECTED TTL/LS INPUTS USUALLY ASSUME THE H STATE... BUT DON'T COUNT ON IT! IF AN INPUT IS SUPPOSED TO BE FIXED AT H, CONNECT IT TO V_{cc}.

4. IF AN INPUT IS SUPPOSED TO BE FIXED AT L, CONNECT IT TO GND.

5. CONNECT UNUSED AND/NAND/OR INPUTS TO A USED INPUT OF THE SAME CHIP.

6. FORCE OUTPUTS OF UNUSED GATES H TO SAVE CURRENT (NAND – ONE INPUT H; NOR – ALL INPUTS L).

7. USE AT LEAST ONE DECOUPLING CAPACITOR (0.01 – 0.1 μF) FOR EVERY 5-10 GATE PACKAGES, ONE FOR EVERY 2-5 COUNTERS AND REGISTERS AND ONE FOR EACH ONE-SHOT. DECOUPLING CAPACITORS NEUTRALIZE THE HEFTY POWER SUPPLY SPIKES THAT OCCUR WHEN A TTL/LS OUTPUT CHANGES STATES. THEY MUST HAVE SHORT LEADS AND BE CONNECTED FROM V_{cc} TO GND AS NEAR THE TTL/LS ICs AS POSSIBLE.

8. AVOID LONG WIRES WITHIN CIRCUITS

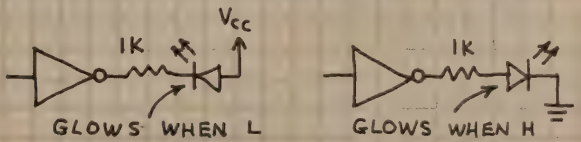
9. IF THE POWER SUPPLY IS NOT ON THE CIRCUIT BOARD, CONNECT A 1–10μF CAPACITOR ACROSS THE POWER LEADS WHERE THEY ARRIVE AT THE BOARD.

INTERFACING TTL/LS

1. 1 TTL OUTPUT WILL DRIVE UP TO 10 TTL OR 20 LS INPUTS.

2. 1 LS OUTPUT WILL DRIVE UP TO 5 TTL OR 10 LS INPUTS.

3. TTL/LS LED DRIVERS:



TTL/LS TROUBLESHOOTING

1. DO ALL INPUTS GO SOMEWHERE?

2. ARE ALL IC PINS INSERTED INTO THE BOARD OR SOCKET?

3. DOES THE CIRCUIT OBEY ALL TTL/LS OPERATING REQUIREMENTS?

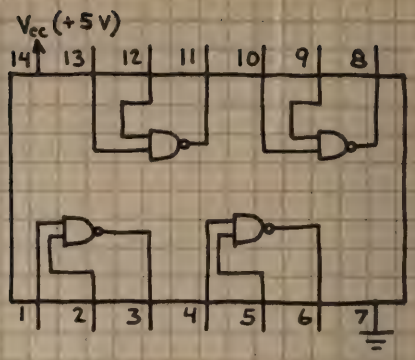
4. HAVE YOU FORGOTTEN A CONNECTION?

5. HAVE YOU USED ENOUGH DECOUPLING CAPACITORS? ARE THEIR LEADS SHORT?

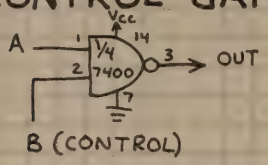
6. IS V_{cc} AT EACH CHIP WITHIN RANGE?

QUAD NAND GATE
7400/74LS00

THE BASIC BUILDING BLOCK CHIP FOR THE ENTIRE TTL FAMILY. VERY EASY TO USE. HUNDREDS OF APPLICATIONS.

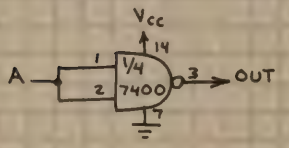


CONTROL GATE



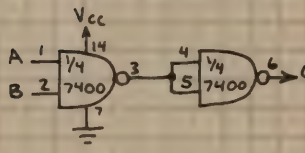
A	B	OUT
L	L	H
L	H	H
H	L	H
H	H	L

INVERTER



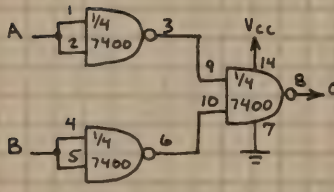
A	OUT
L	H
H	L

AND GATE



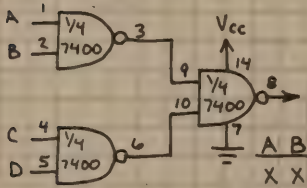
A	B	OUT
L	L	L
L	H	L
H	L	L
H	H	H

OR GATE



A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	H

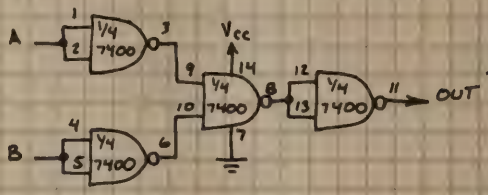
AND-OR GATE



A	B	C	D	OUT
X	X	H	H	H
H	H	X	X	H
H	H	H	H	H

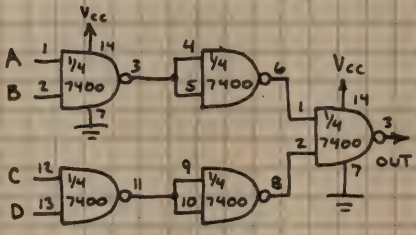
NOTE: PIN NUMBERS CAN BE REARRAGED IF DESIRED.

NOR GATE



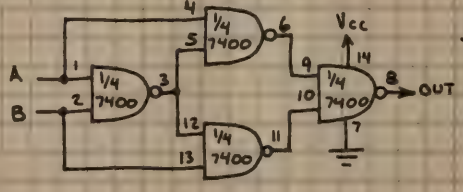
A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	L

4-INPUT NAND GATE



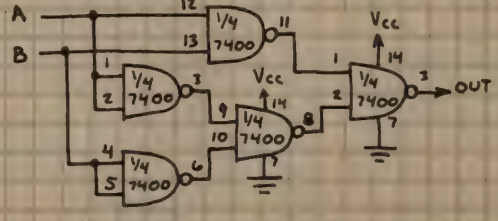
A	B	C	D	OUT
L	X	X	X	H
X	L	X	X	H
X	X	L	X	H
X	X	X	L	H
H	H	H	H	L

EXCLUSIVE-OR GATE



A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	L

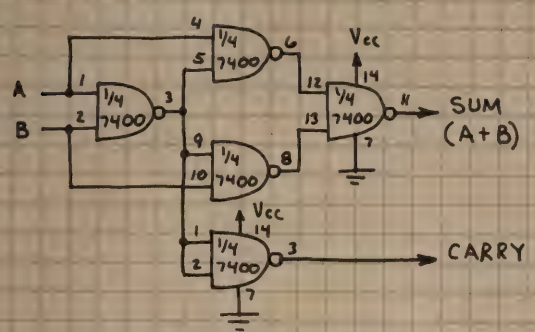
EXCLUSIVE-NOR GATE



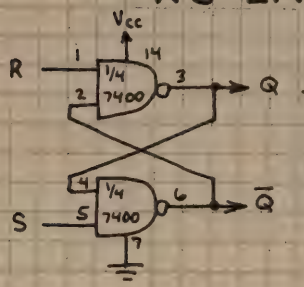
A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	H

QUAD NAND GATE (CONTINUED)
7400/74LS00

HALF ADDER

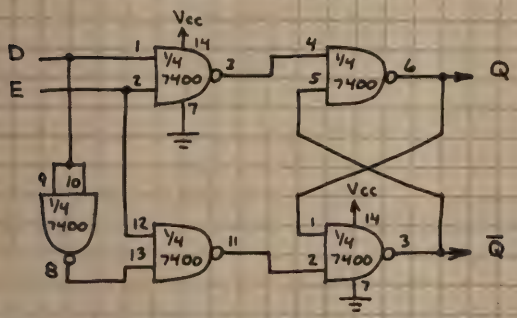


RS LATCH



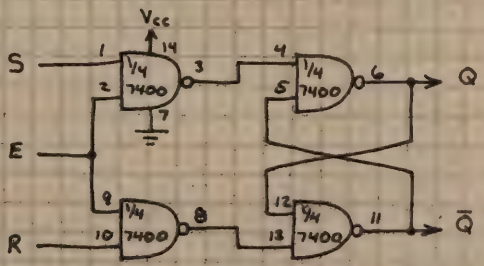
R	S	Q	$\bar{Q}$
L	L	NOT ALLOWED	
L	H	H	L
H	L	L	H
H	H	NO CHANGE	

D FLIP-FLOP



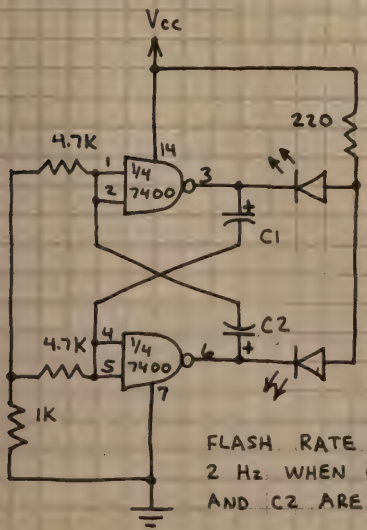
WHEN ENABLE (E) INPUT IS HIGH, Q OUTPUT FOLLOWS D INPUT. NO CHANGE WHEN E IS LOW.

GATED RS LATCH



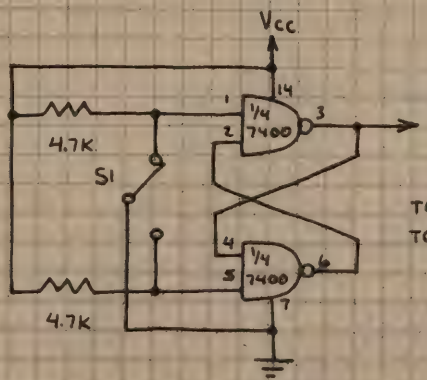
FUNCTIONS AS RS LATCH WHEN ENABLE (E) INPUT IS HIGH. IGNORES RS INPUTS WHEN E IS LOW.

LED DUAL FLASHER



FLASH RATE IS 2 Hz WHEN C1 AND C2 ARE 47μF.

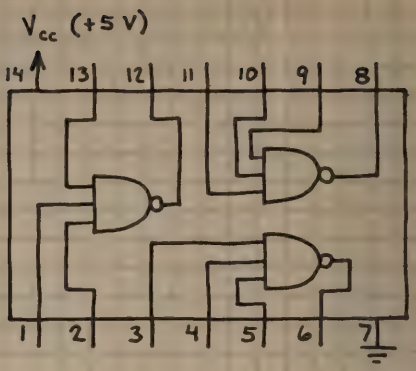
SWITCH DEBOUNCER



TOGGLE S1 TO OPERATE.

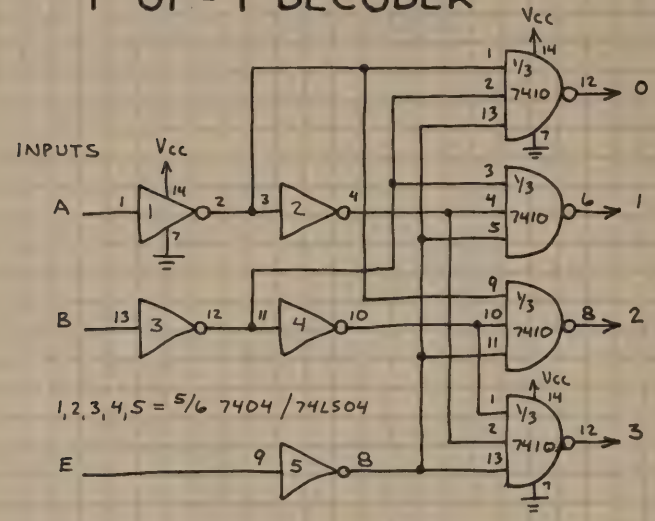
PROVIDES NOISE FREE OUTPUT FROM STANDARD SPDT TOGGLE SWITCH.

TRIPLE 3-INPUT NAND GATE 74LS10



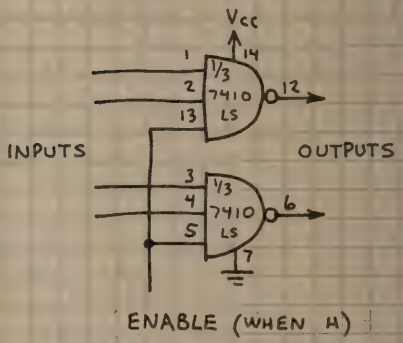
VERY USEFUL IN DO-IT-YOURSELF DECODERS. ALSO VERY HANDY FOR ADDING ENABLE CONTROL TO DIGITAL CIRCUITS.

1-OF-4 DECODER



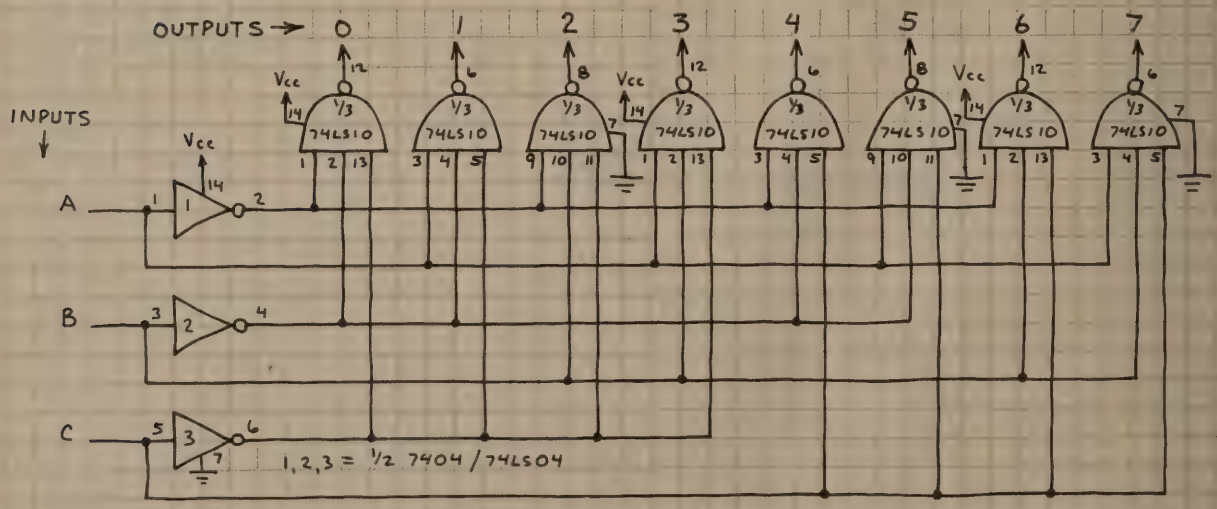
FOR EACH OF 4 POSSIBLE BINARY INPUTS (LL, LH, HL AND HH) ONE INPUT GOES LOW WHILE ALL OTHERS STAY HIGH. E SHOULD BE H.

ENABLE INPUT



TYPICAL ENABLE INPUT CIRCUIT. USE THIS METHOD TO CONTROL ONE OR MORE GATES.

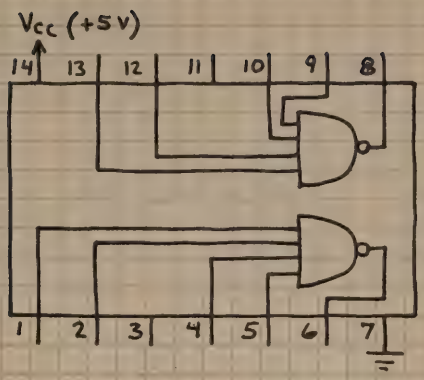
1-OF-8 DECODER



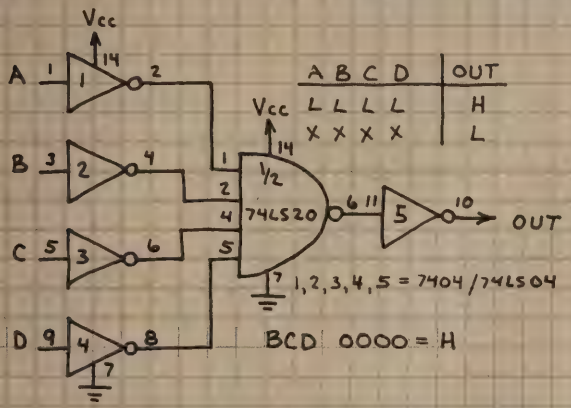
FOR EACH OF 8 POSSIBLE BINARY INPUTS (LLL, LLH, LHL ... HHH), ONE OUTPUT GOES LOW WHILE ALL OTHERS STAY HIGH.

DUAL 4-INPUT NAND GATE
74LS20

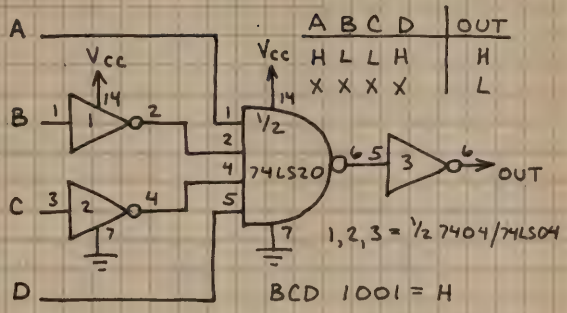
MANY DECODER AND ENCODER APPLICATIONS. CAN BE USED AS DUAL 3-INPUT NAND GATE WITH ENABLE (CONTROL) INPUT FOR EACH GATE.



BCD DECODERS



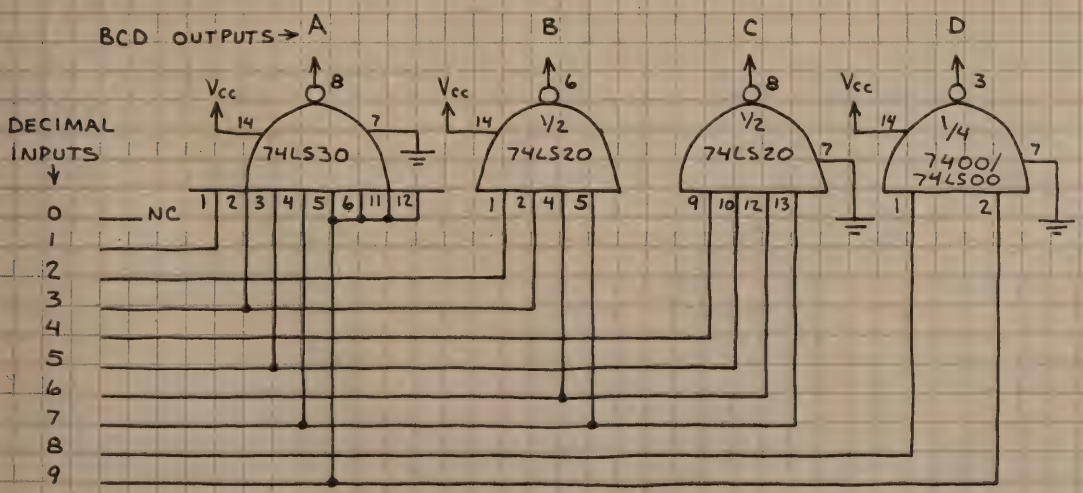
A	B	C	D	OUT
L	L	L	L	H
X	X	X	X	L



A	B	C	D	OUT
H	L	L	H	H
X	X	X	X	L

OUTPUTS GO HIGH WHEN APPROPRIATE BCD WORD APPEARS AT INPUTS DCBA. OUTPUTS STAY LOW FOR ALL OTHER INPUTS. (OMIT FINAL INVERTER TO PROVIDE ACTIVE LOW OUTPUT.) USE THIS METHOD TO DECODE ANY 4-BIT NIBBLE.

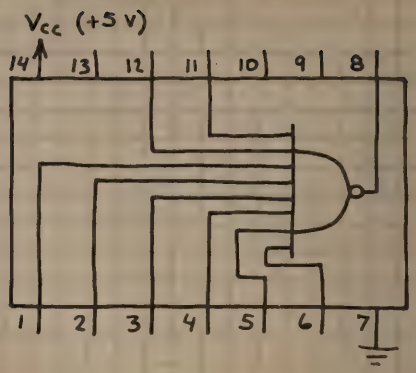
DECIMAL-TO-BINARY CODED DECIMAL (BCD) ENCODER



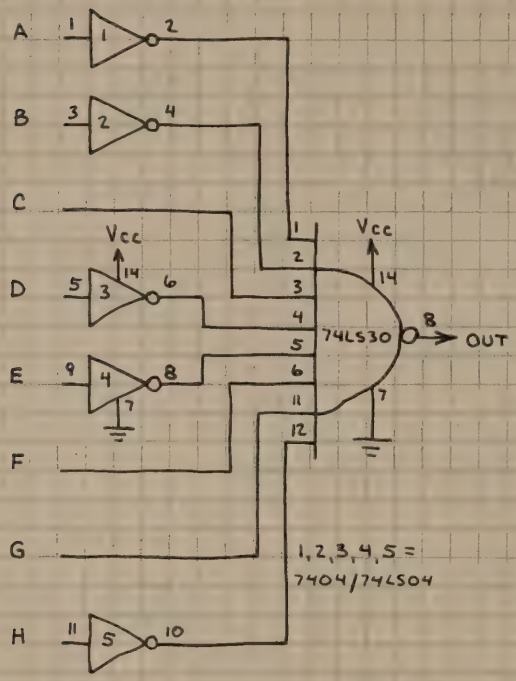
SELECTED INPUT SHOULD BE LOW AND ALL OTHER INPUTS SHOULD BE HIGH. BCD EQUIVALENT WILL APPEAR AT THE OUTPUTS.

8-INPUT NAND GATE
74LS30

HANDY FOR BYTE-SIZE (8-BIT) DECODING APPLICATIONS. CAN DECODE UP TO 256 INPUT COMBINATIONS. ALSO USEFUL AS PROGRAMMABLE NAND GATE.

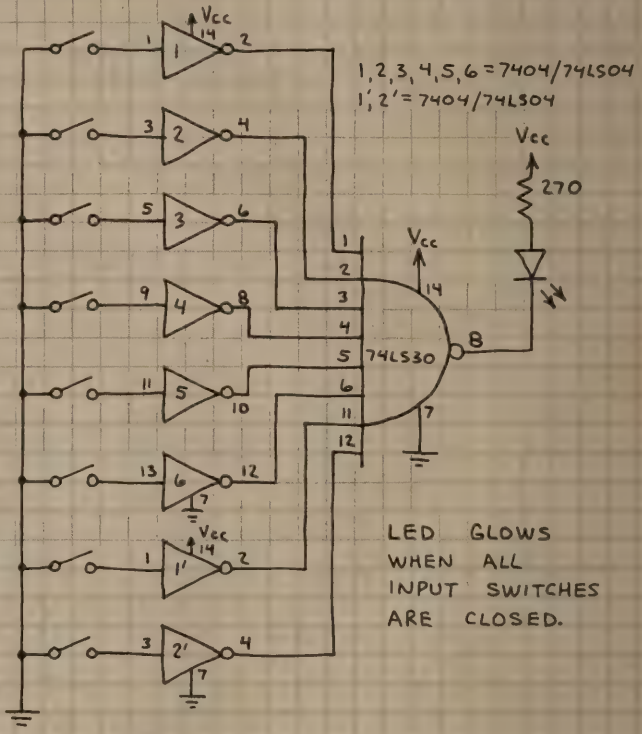


8-BIT DECODER



OUTPUT GOES LOW ONLY WHEN INPUT IS LHHLLHLL (DECIMAL 100). UP TO 256 INPUTS CAN BE DECODED BY REARRANGING UP TO 8 INPUT INVERTERS.

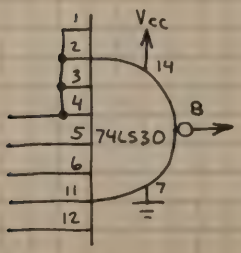
UNANIMOUS VOTE DETECTOR



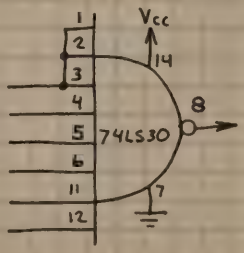
LED GLOWS WHEN ALL INPUT SWITCHES ARE CLOSED.

PROGRAMMABLE NAND GATES

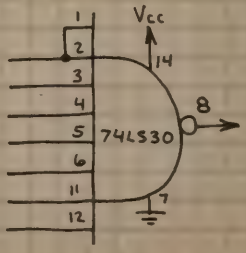
5-INPUT



6-INPUT

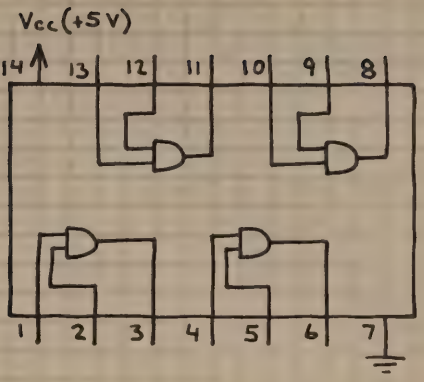


7-INPUT

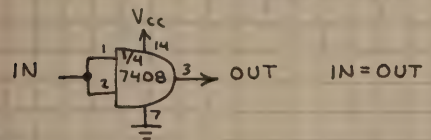


QUAD AND GATE
7408/74LS08

ONE OF THE BASIC BUILDING BLOCK CHIPS. NOT AS VERSATILE, HOWEVER, AS THE 7400/74LS00 QUAD NAND GATE.

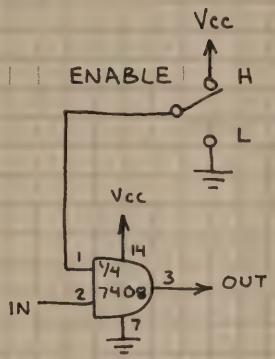


AND GATE BUFFER



USE FOR INTERFACING WITHOUT CHANGING LOGIC STATES.

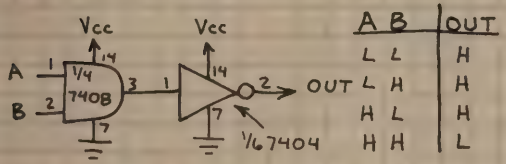
DIGITAL TRANSMISSION GATE



IN	E	OUT
L	L	L
L	H	L
H	L	L
H	H	H

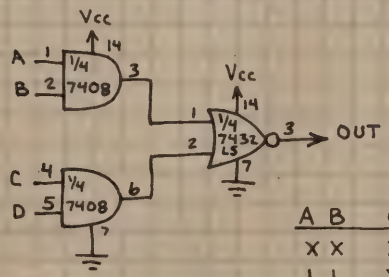
E = ENABLE

NAND GATE



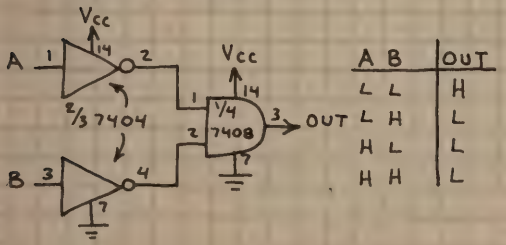
A	B	OUT
L	L	H
L	H	H
H	L	H
H	H	L

AND-OR-INVERT GATE



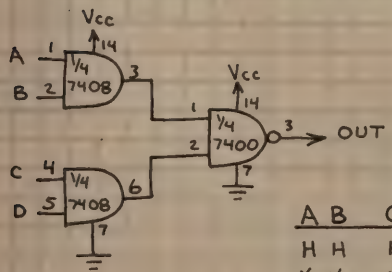
A	B	C	D	OUT
X	X	X	X	H
1	1	X	X	L
1	1	1	1	L

NOR GATE



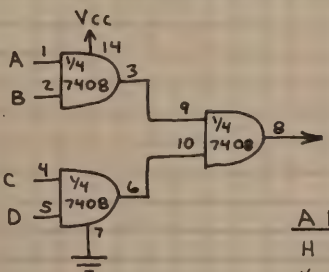
A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	L

4-INPUT NAND GATE



A	B	C	D	OUT
H	H	H	H	L
X	X	X	X	H

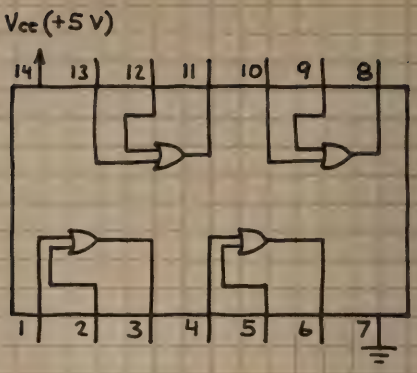
4-INPUT AND GATE



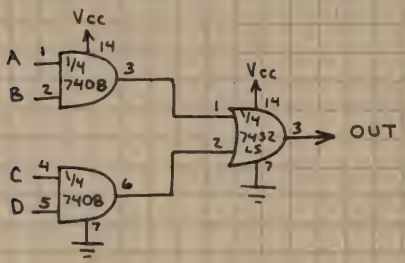
A	B	C	D	OUT
H	H	H	H	H
X	X	X	X	L

QUAD OR GATE
74LS32

FOUR 2-INPUT OR GATES. NOT AS VERSATILE AS 7402/74LS02 QUAD NOR GATE, BUT VERY USEFUL IN SIMPLE DATA SELECTORS.

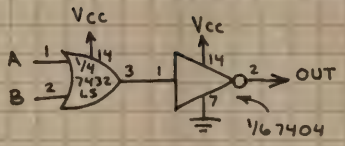


AND-OR CIRCUIT



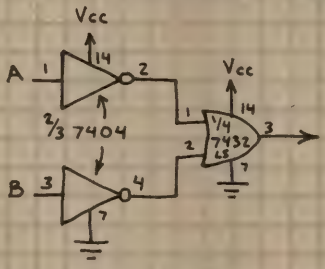
OUTPUT GOES HIGH WHEN BOTH INPUTS OF EITHER OR BOTH AND GATES ARE HIGH; OTHERWISE THE OUTPUT IS LOW. THIS BASIC CIRCUIT IS USED TO MAKE DATA SELECTORS... AS SHOWN BELOW →

NOR GATE



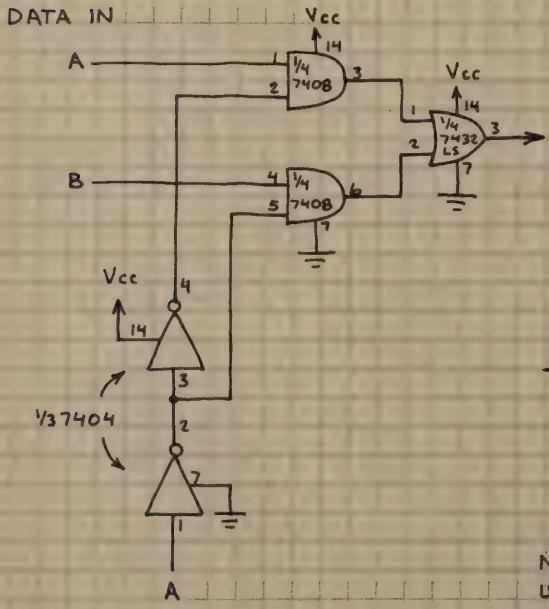
A	B	OUT
L	L	H
L	H	L
H	L	L
H	H	L

NAND GATE



A	B	OUT
L	L	H
L	H	H
H	L	H
H	H	L

2-INPUT DATA SELECTOR

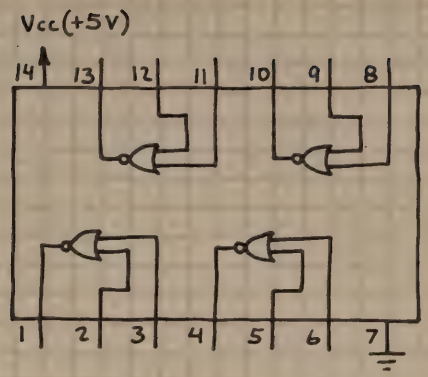


SELECTS 1-OF-2 INPUTS AND TRANSMITS ITS LOGIC STATE TO THE OUTPUT.

ADDRESS	DATA IN		OUT
A	B	A	
L	X	L	L
L	X	H	H
H	L	X	L
H	H	X	H

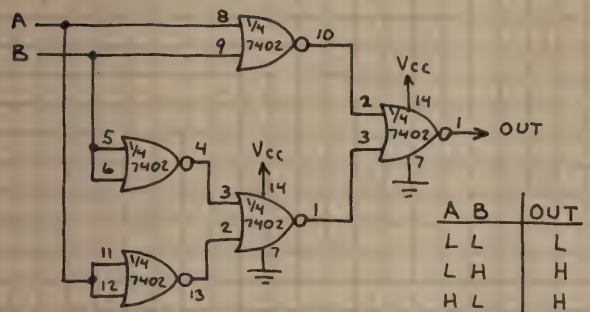
NOTE: FOR 3-INPUT DATA SELECTOR, USE 74LS27 NOR GATE FOLLOWED BY INVERTER AND PRECEEDED BY 74LS10 3-INPUT AND GATES.

QUAD NOR GATE
7402/74LS02



JUST AS VERSATILE AS THE 7400/74LS00 QUAD NAND GATE... BUT NOT USED AS OFTEN. ADD INVERTER (7404/74LS04) TO BOTH INPUTS OF A NOR GATE AND AN AND GATE IS FORMED.

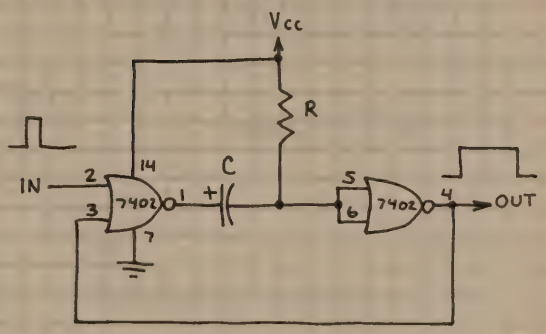
EXCLUSIVE-OR GATE



A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	L

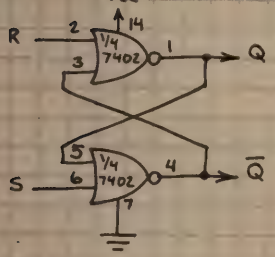
THIS CIRCUIT IS EQUIVALENT TO A BINARY HALF-ADDER.

ONE-SHOT



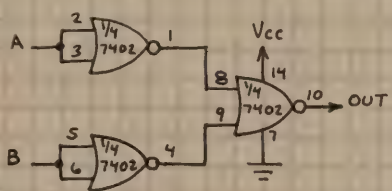
THIS CIRCUIT IS A MONOSTABLE MULTIVIBRATOR OR PULSE STRETCHER. AN INPUT PULSE TRIGGERS AN OUTPUT PULSE WITH A DURATION DETERMINED BY R AND C. OUTPUT PULSE WIDTH IS APPROXIMATELY 0.8RC.

RS LATCH



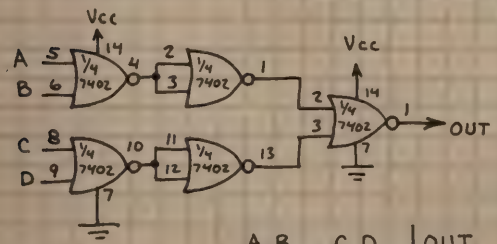
R	S	Q	$\overline{Q}$
L	L	NO CHANGE	
L	H	H	L
H	L	L	H
H	H	NOT ALLOWED	

AND GATE



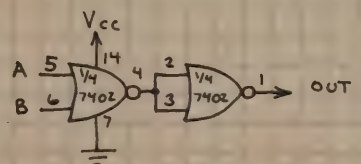
A	B	OUT
L	L	L
L	H	L
H	L	L
H	H	H

4-INPUT NOR GATE



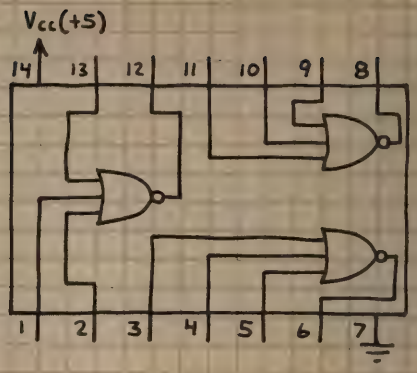
A	B	C	D	OUT
L	L	L	L	H
X	X	X	X	L

OR GATE



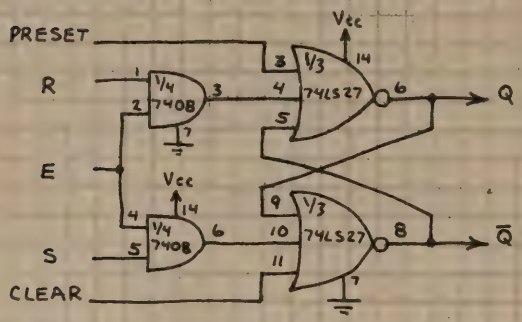
A	B	OUT
L	L	L
L	H	H
H	L	H
H	H	H

TRIPLE 3-INPUT NOR GATE
74LS27



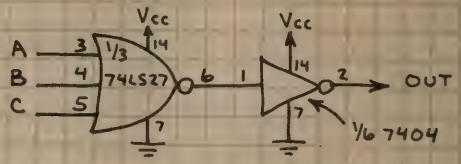
USEFUL FOR DATA SELECTORS AND NOR GATE FLIP-FLOPS THAT REQUIRE CLEAR AND PRESET INPUTS.

GATED RS LATCH



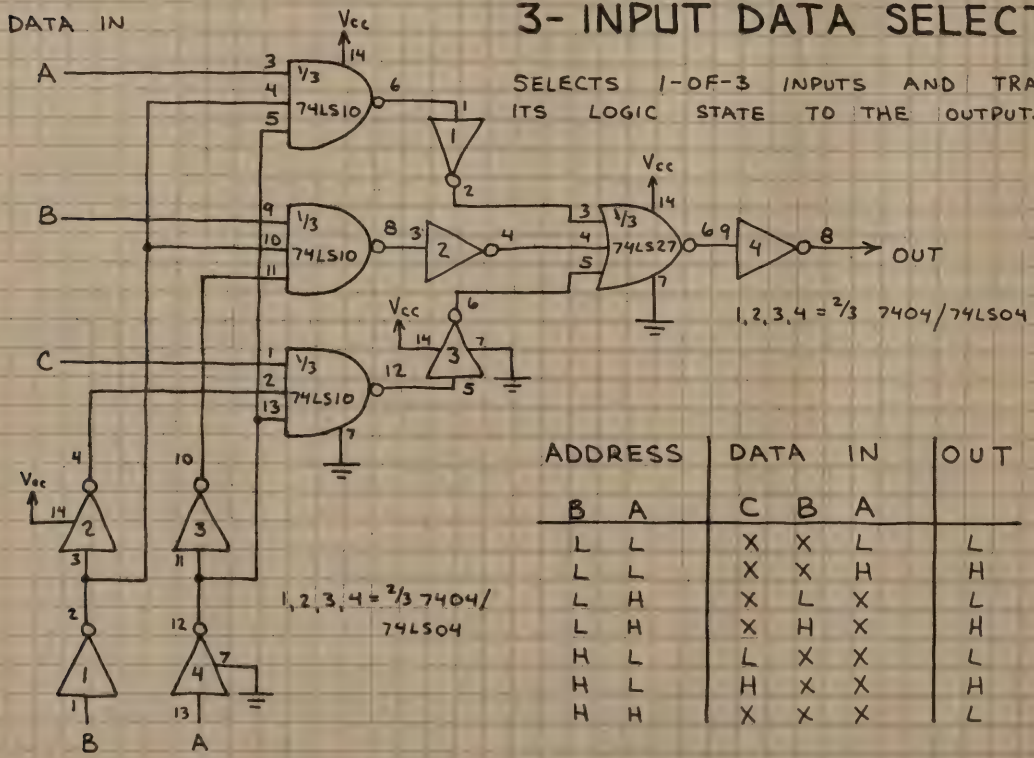
FUNCTIONS AS RS LATCH WHEN E (ENABLE) INPUT IS HIGH. IGNORES RS INPUTS WHEN E IS LOW.

3-INPUT OR GATE



3-INPUT DATA SELECTOR

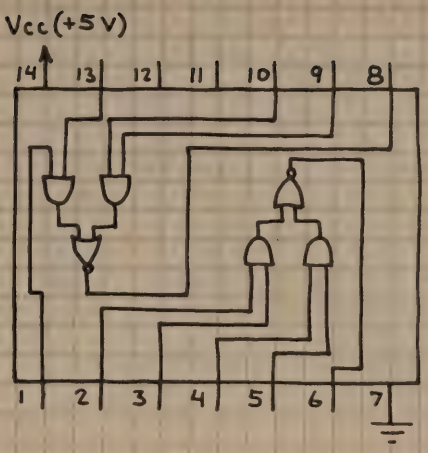
SELECTS 1-OF-3 INPUTS AND TRANSMITS ITS LOGIC STATE TO THE OUTPUT.



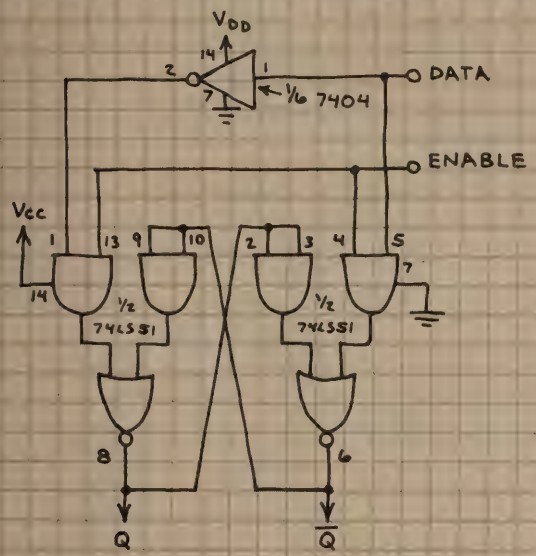
ADDRESS		DATA IN			OUT
B	A	C	B	A	
L	L	X	X	L	L
L	L	X	X	H	H
L	H	X	L	X	L
L	H	X	H	X	H
H	L	L	X	X	L
H	L	H	X	X	H
H	H	X	X	X	L

DUAL AND-OR-INVERT GATE
74LS51

VERY VERSATILE BUILDING BLOCK CHIP. IDEAL FOR CUSTOMIZED DATA SELECTORS, LATCHES AND EXPANSION OF A SINGLE INPUT TO AN AND-OR INPUT.

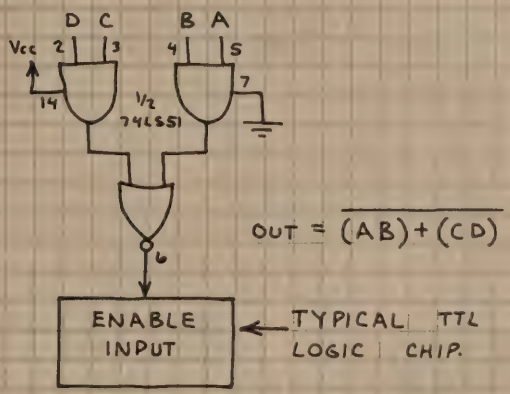


LATCH WITH ENABLE INPUT



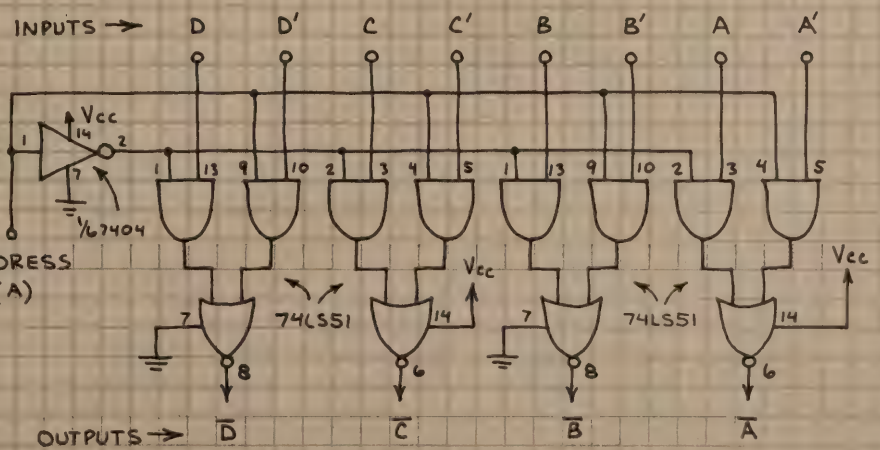
Q OUTPUT FOLLOWS DATA INPUT WHEN ENABLE INPUT IS HIGH. NO CHANGE WHEN ENABLE IS LOW.

TYPICAL AND-OR INPUT



THIS CIRCUIT SELECTS 1-OF-2 4-BIT WORDS. NOTE THAT THE SELECTED WORD IS INVERTED AT THE OUTPUTS. THE CIRCUIT REQUIRES TWO 74LS51 CHIPS.

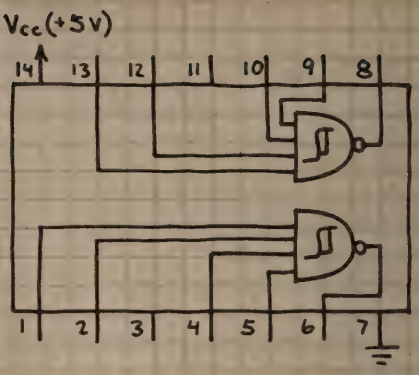
1-OF-2 DATA SELECTOR



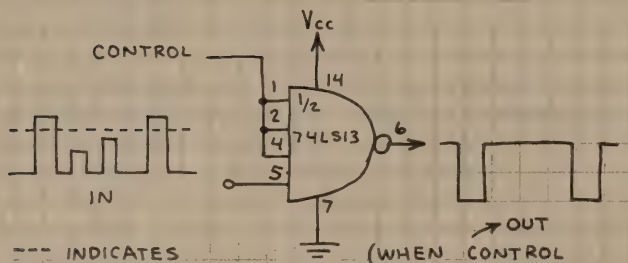
A	INPUT X	INPUT X	OUT
H	X	L	H
H	X	H	L
L	L	X	H
L	H	X	L

DUAL NAND SCHMITT TRIGGER
74LS13

TWO 4-INPUT NAND GATES WITH A SWITCHING THRESHOLD. OUTPUTS GO LOW WHEN INPUTS EXCEED 1.7 VOLTS. OUTPUTS GO HIGH WHEN INPUTS FALL TO 0.9 VOLT. IF ANY INPUT IS LOW, THE RESPECTIVE OUTPUT WILL STAY HIGH AND THE GATE WILL NOT TRIGGER.



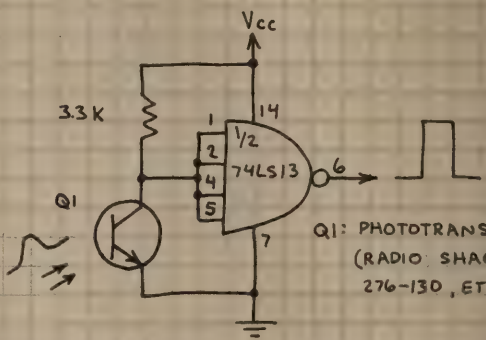
GATED THRESHOLD DETECTOR



--- INDICATES THRESHOLD LEVEL.

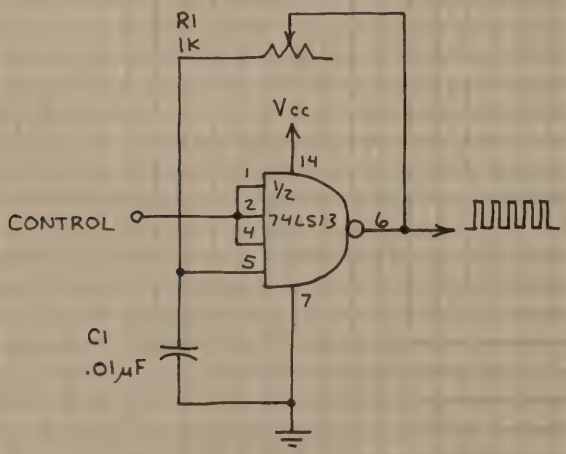
(WHEN CONTROL INPUT IS HIGH.)

PHOTOTRANSISTOR RECEIVER



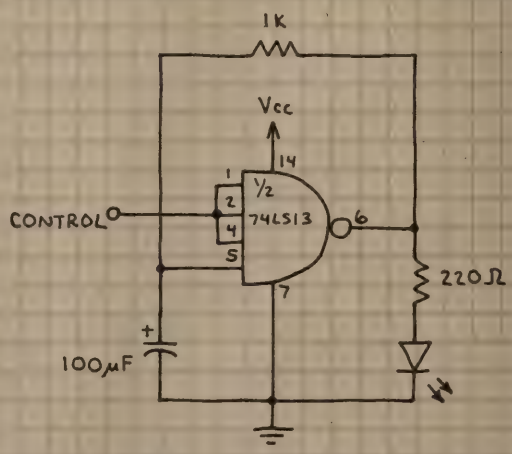
USE TO CLEAN UP INCOMING LIGHT PULSES.

GATED OSCILLATOR



OSCILLATES WHEN CONTROL IS HIGH. CHANGE R1 AND C1 TO CHANGE FREQUENCY. OK TO USE THIS CIRCUIT AS GATED CLOCK FOR LOGIC CIRCUITS.

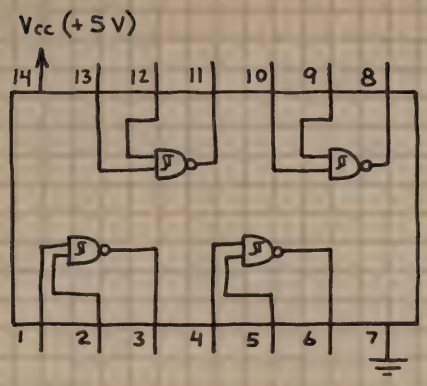
TWO-STATE LED FLASHER



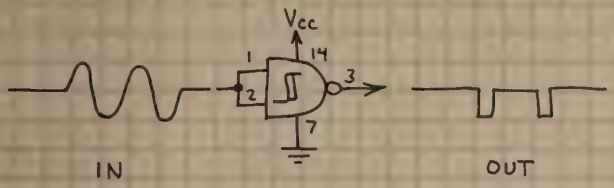
LED FLASHES TWICE EACH SECOND WHEN CONTROL INPUT IS HIGH. LED STAYS ON AND DOES NOT FLASH WHEN CONTROL IS LOW.

QUAD NAND SCHMITT TRIGGER 74LS132

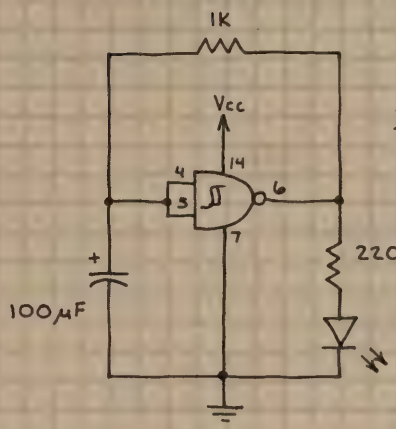
NAND GATES WITH A SWITCHING THRESHOLD. OUTPUTS GO LOW WHEN INPUTS EXCEED 1.7 VOLTS. OUTPUTS GO LOW WHEN INPUTS FALL TO 0.9 VOLT. VERY USEFUL FOR CLEANING UP DIGITAL SIGNALS BEFORE THEY ARE ALLOWED TO ENTER A LOGIC CIRCUIT.



WAVE SHAPER

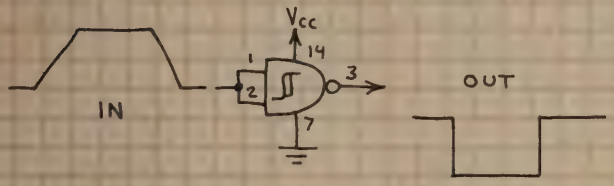


LED FLASHER



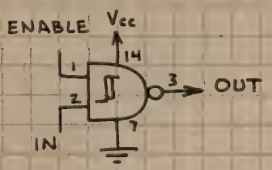
FLASHES ABOUT TWICE EACH SECOND.

PULSE RESTORER

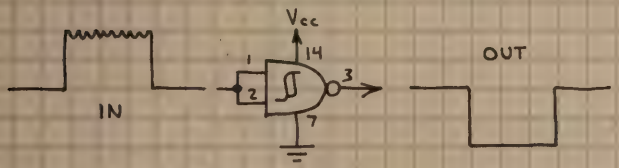


ADDING ENABLE INPUT

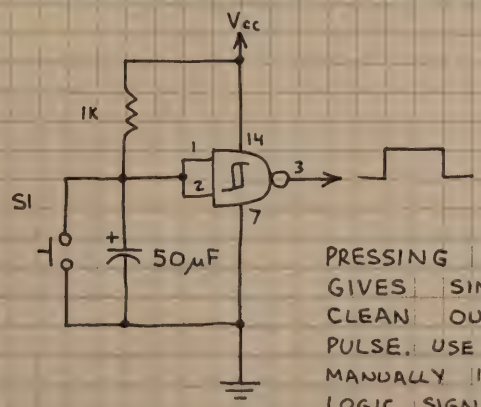
TRIGGERS WHEN ENABLE INPUT IS HIGH. OUTPUT HIGH WHEN ENABLE LOW.



NOISE ELIMINATOR

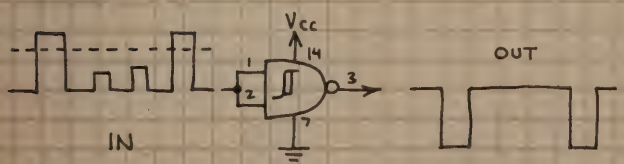


BOUNCELESS PUSHBUTTON



PRESSING SI GIVES SINGLE, CLEAN OUTPUT PULSE. USE FOR MANUALLY INJECTING LOGIC SIGNALS, ETC.

THRESHOLD DETECTOR



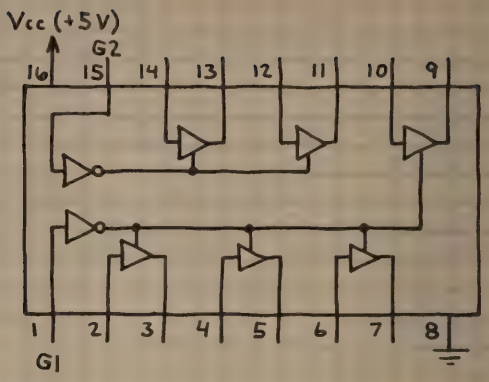
--- INDICATES THRESHOLD LEVEL.

HEX 3-STATE BUS DRIVER 74LS367

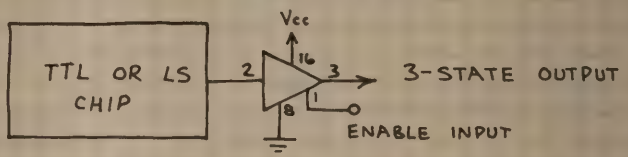
EACH GATE FUNCTIONS AS A NON-INVERTING BUFFER WHEN ITS ENABLE INPUT (G1 OR G2) IS LOW. OTHERWISE EACH GATE'S OUTPUT ENTERS THE HIGH IMPEDANCE (HI-Z) STATE.

HERE'S THE TRUTH TABLE:

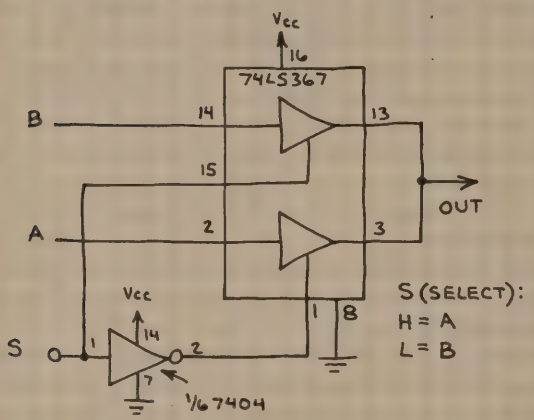
G	IN	OUT
H	X	HI-Z
L	L	L
L	H	H



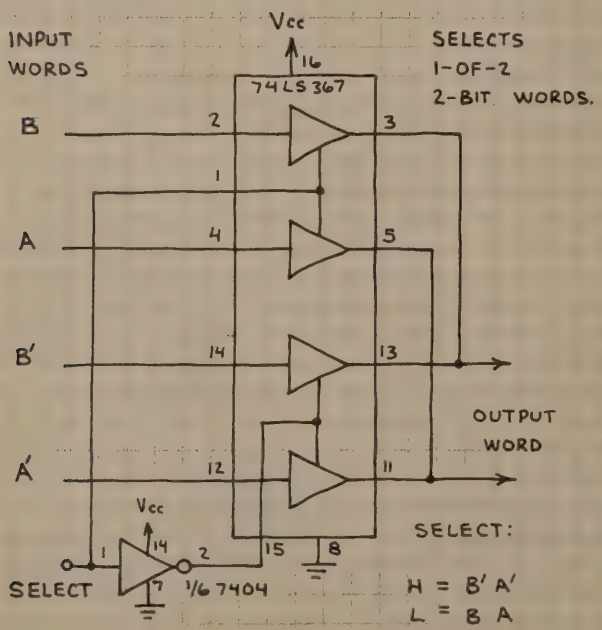
ADDING 3-STATE OUTPUT TO TTL



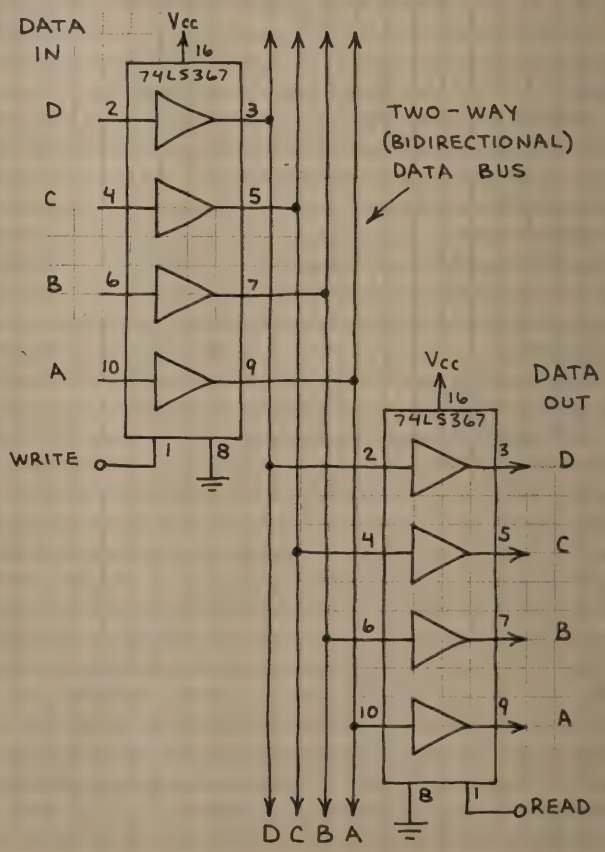
1-OF-2 DATA SELECTOR



1-OF-2 DATA SELECTOR



BIDIRECTIONAL DATA BUS

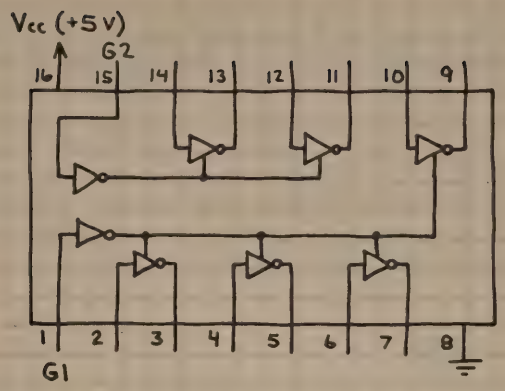


HEX 3-STATE BUS DRIVER 74LS368

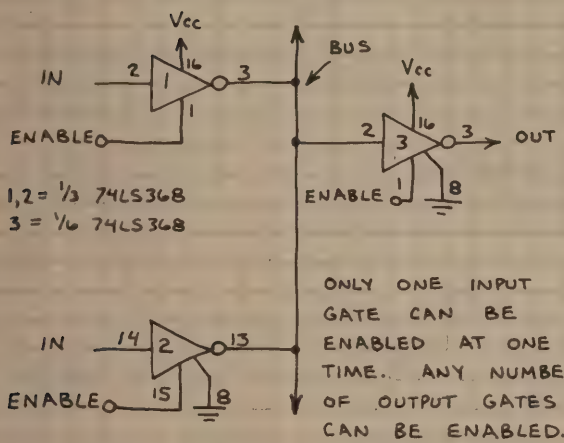
EACH GATE FUNCTIONS AS AN INVERTER WHEN ITS ENABLE INPUT (G1 OR G2) IS LOW. OTHERWISE EACH GATE'S OUTPUT ENTERS THE HIGH IMPEDANCE (HI-Z) STATE.

HERE'S THE TRUTH TABLE:

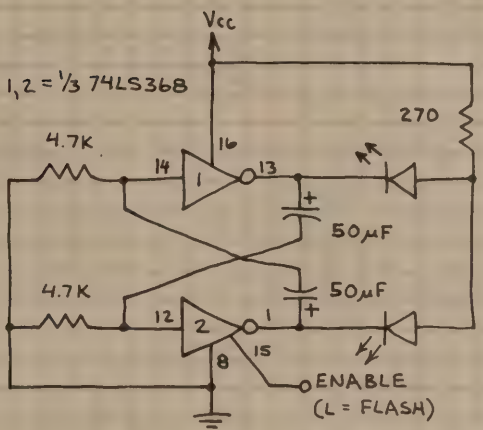
G	IN	OUT
H	X	HI-Z
L	L	H
L	H	L



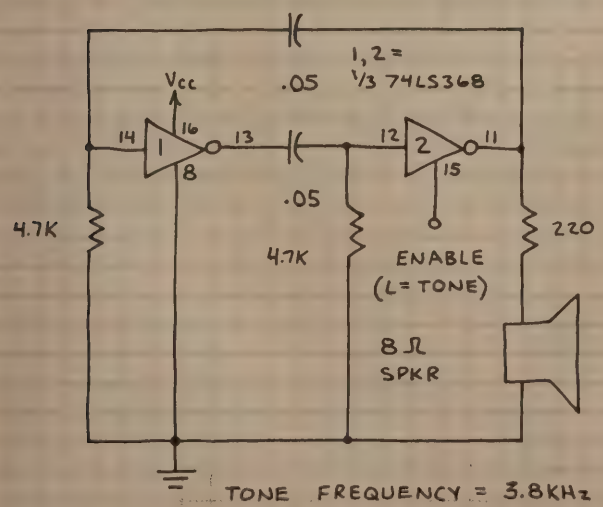
BIDIRECTIONAL DATA BUS



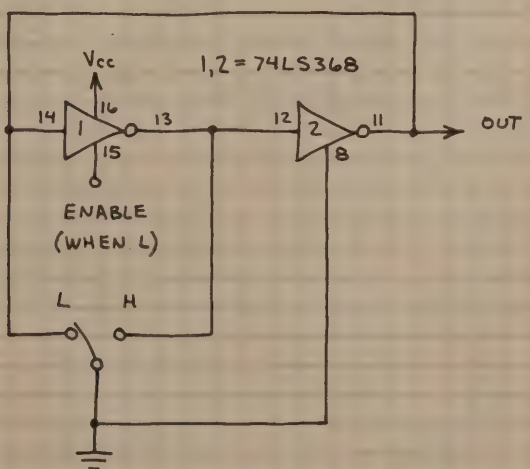
GATED LED FLASHER



GATED TONE SOURCE

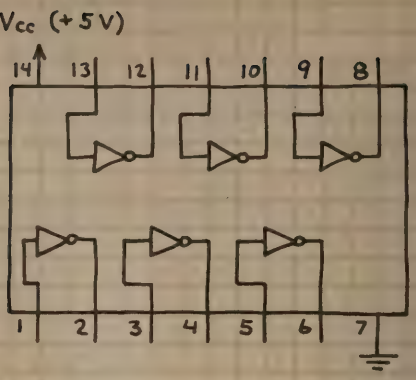


BOUNCELESS SWITCH (WITH ENABLE)

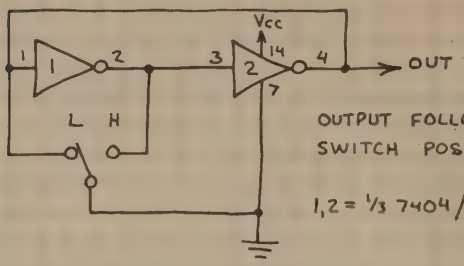


HEX INVERTER
7404/74LS04

VERY IMPORTANT IN ALMOST ALL LOGIC CIRCUITS. CHANGES AN INPUT TO ITS COMPLEMENT (i.e. H→L AND L→H).



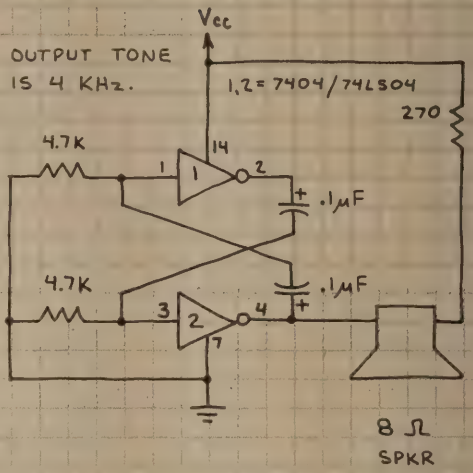
BOUNCEFREE SWITCH



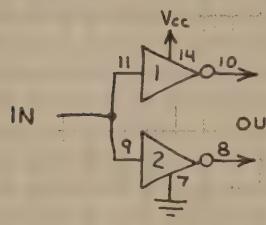
OUTPUT FOLLOWS SWITCH POSITION.

1,2 = 1/3 7404/74LS04

AUDIO OSCILLATOR

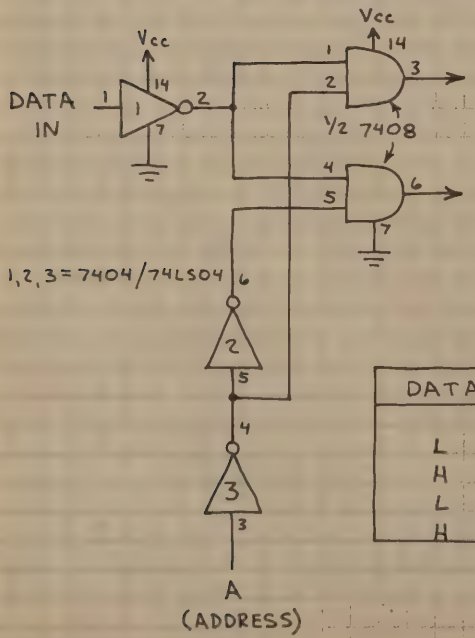


UNIVERSAL EXPANDER



ALLOWS ONE SIGNAL TO CONTROL 2 OR MORE INPUTS.

1-OF-2 DEMULTIPLEXER



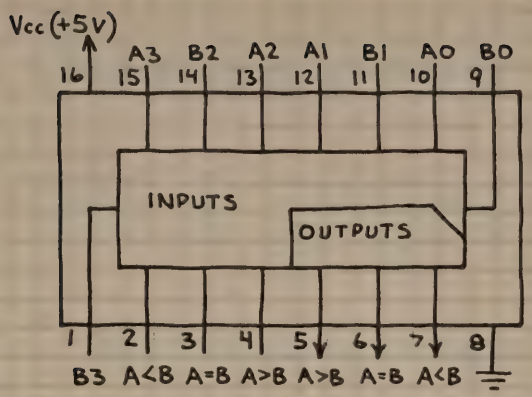
THIS CIRCUIT STEERS THE INPUT BIT TO THE OUTPUT SELECTED BY THE ADDRESS.

THIS TECHNIQUE CAN BE USED TO MAKE MULTIPLE OUTPUT DEMULTIPLEXERS.

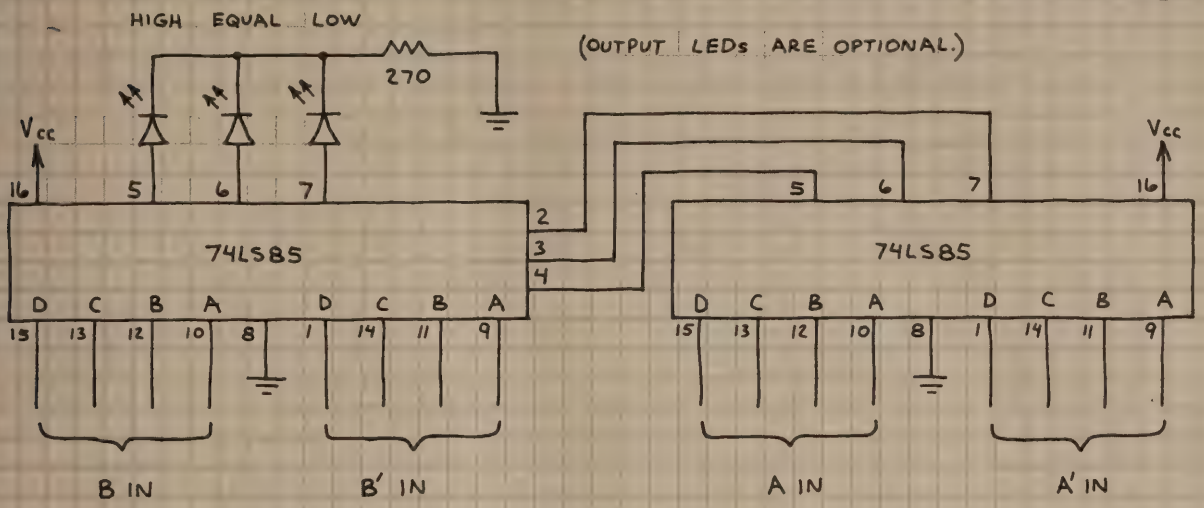
DATA	ADDRESS	OUT A	OUT B
L	L	L	H
H	L	H	H
L	H	H	L
H	H	H	H

4-BIT MAGNITUDE COMPARATOR 74LS85

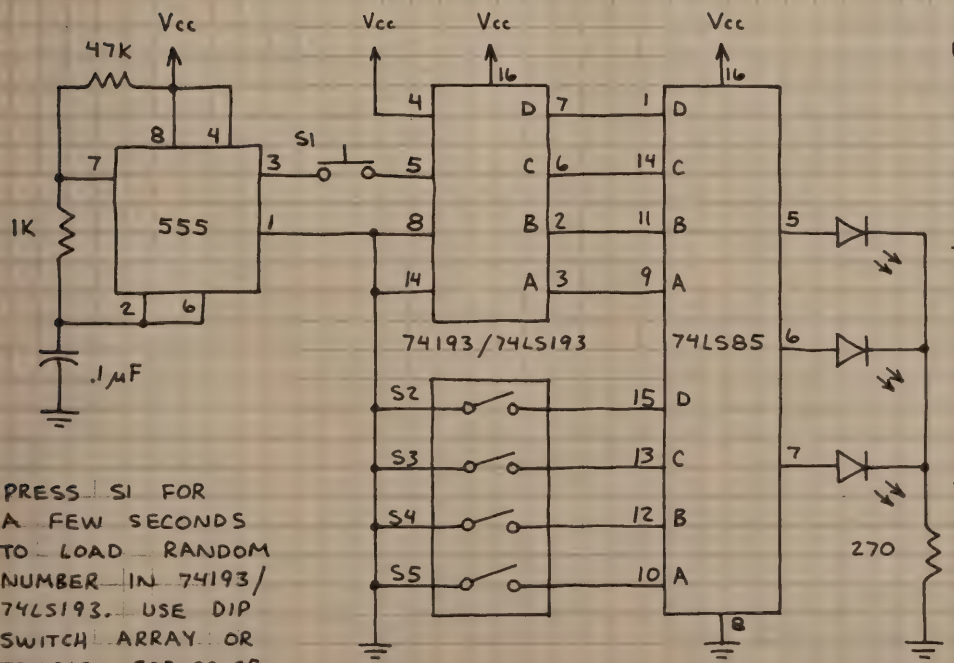
COMPARES TWO 4-BIT WORDS. INDICATES WHICH IS LARGER OR IF THEY ARE EQUAL.



8-BIT COMPARATOR



BINARY HI-LO GAME

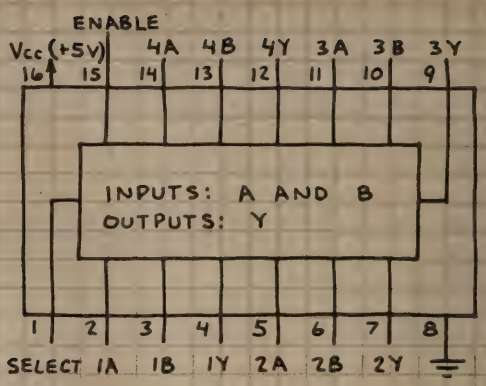


ENTER GUESSES IN S2-S5. AN OPEN SWITCH IS HIGH AND A CLOSED SWITCH IS LOW.

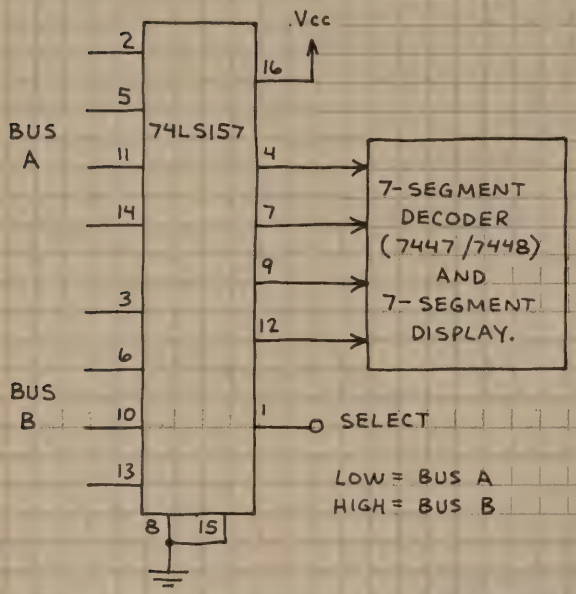
PRESS S1 FOR A FEW SECONDS TO LOAD RANDOM NUMBER IN 74193/74LS193. USE DIP SWITCH ARRAY OR TOGGLES FOR S2-S5

QUAD 1-OF-2 DATA SELECTOR 74LS157

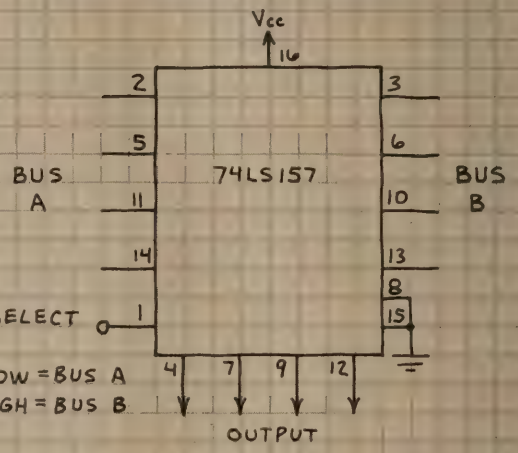
FOUR 2-LINE TO 1-LINE MULTIPLEXERS. MANY USES IN ROUTING DATA. ALL 4 DATA SELECTORS ARE ENABLED WHEN PIN IS IS LOW.



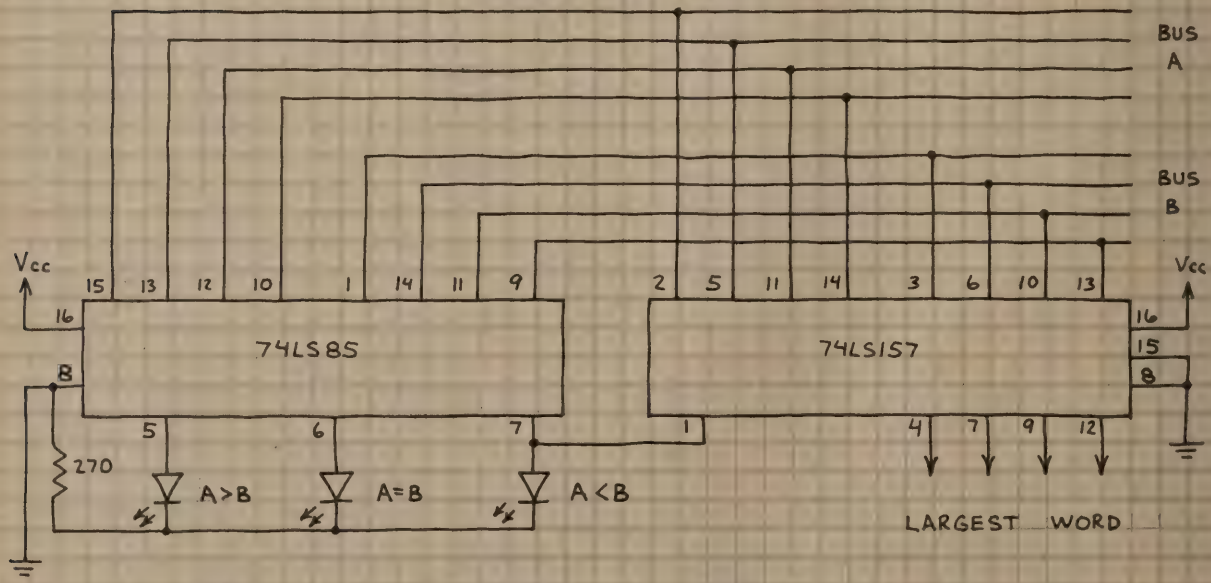
DOUBLE DUTY DISPLAY



BUS SELECTOR



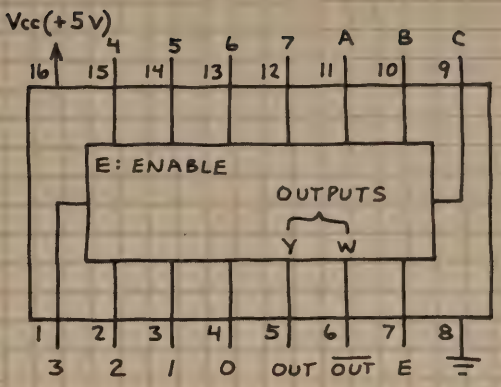
WORD SORTER



THIS CIRCUIT CONTINUALLY MONITORS TWO DATA BUSES. BUS WITH HIGHEST MAGNITUDE DATA WORD IS ROUTED AUTOMATICALLY TO OUTPUT.

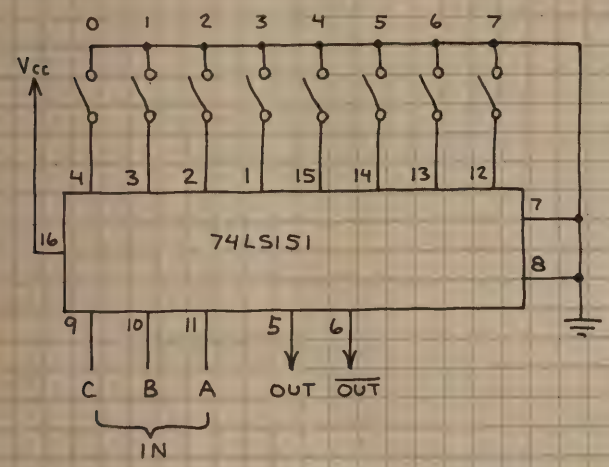
1-OF-8 DATA SELECTOR
74LS151

EQUIVALENT TO 8-LINE TO 1-LINE MULTIPLEXER.

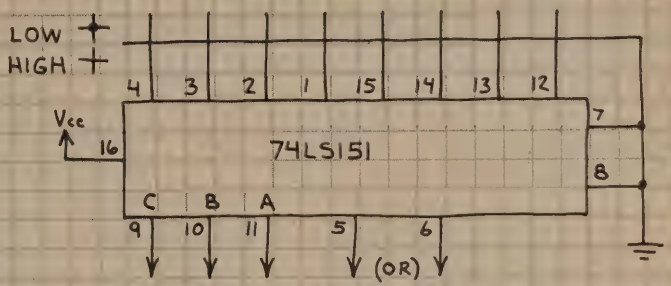


PROGRAMMABLE GATE

3-BIT ADDRESS SELECTS ONE SWITCH AND APPLIES ITS STATUS (OPEN = HIGH AND CLOSED = LOW) TO THE OUTPUT. ANY 3-INPUT LOGIC FUNCTION CAN BE PROGRAMMED IN SECONDS.

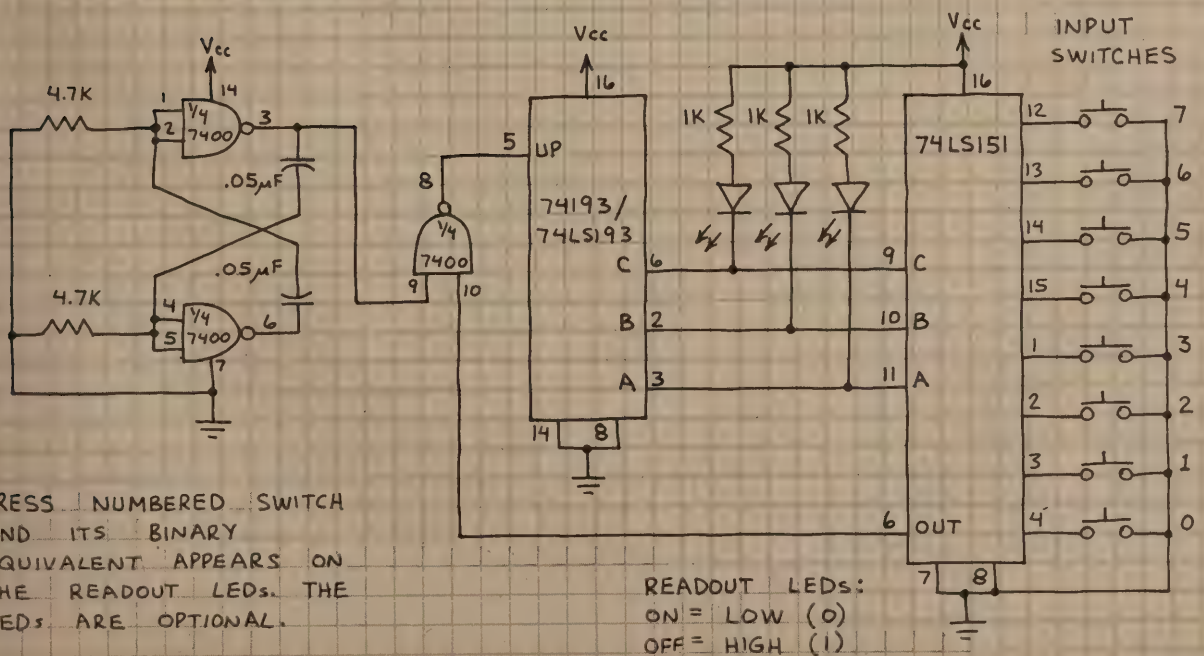


PATTERN GENERATOR



PROGRAM ANY DESIRED LOW-HIGH BIT PATTERN. THEN PLAY IT BACK.

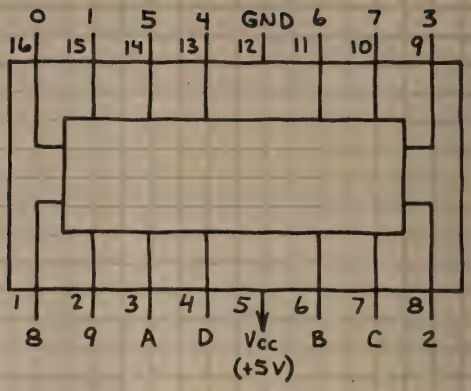
OCTAL KEYBOARD ENCODER



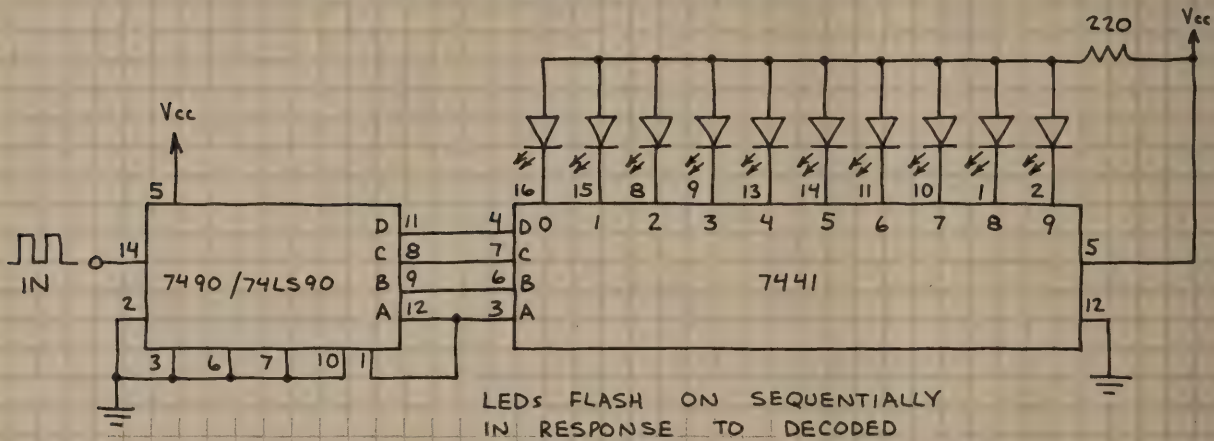
PRESS NUMBERED SWITCH AND ITS BINARY EQUIVALENT APPEARS ON THE READOUT LEDs. THE LEDs ARE OPTIONAL.

BCD-TO-DECIMAL DECODER 7441

DECODES 4-BIT BCD INPUT INTO 1-OF-10 OUTPUTS. SELECTED OUTPUT GOES LOW; ALL OTHERS STAY HIGH. ORIGINALLY DESIGNED TO DRIVE GASEOUS GLOW DISCHARGE TUBES. ALL OUTPUTS GO HIGH FOR BINARY INPUTS EXCEEDING HLLH (1001).

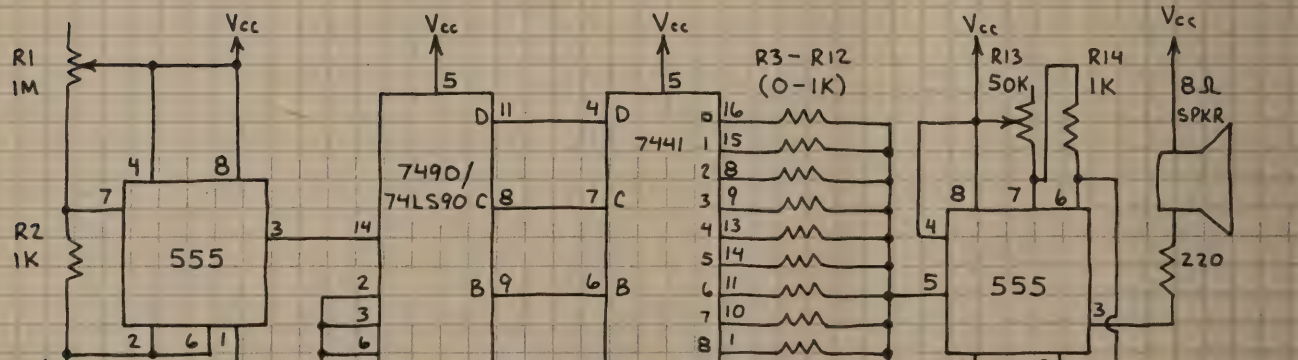


1-OF-10 DECODED COUNTER



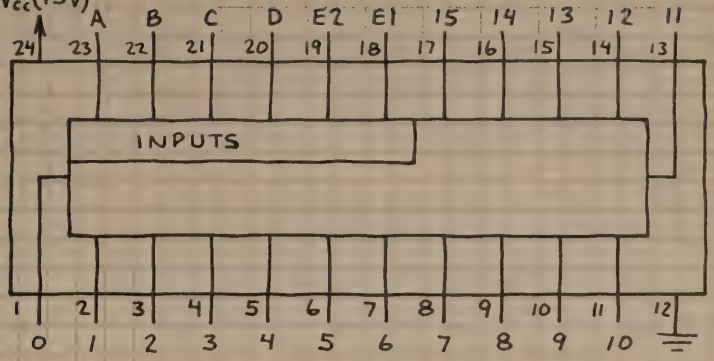
LEDs FLASH ON SEQUENTIALLY IN RESPONSE TO DECODED COUNT. ONLY ONE LED SERIES RESISTOR IS REQUIRED.

10-NOTE TONE SEQUENCER



INCREASE C1 TO DECREASE TEMPO. INCREASE C2 TO INCREASE TONE FREQUENCIES. TONES ARE DETERMINED BY R3-R12.

4-LINE TO 16-LINE DECODER 74154



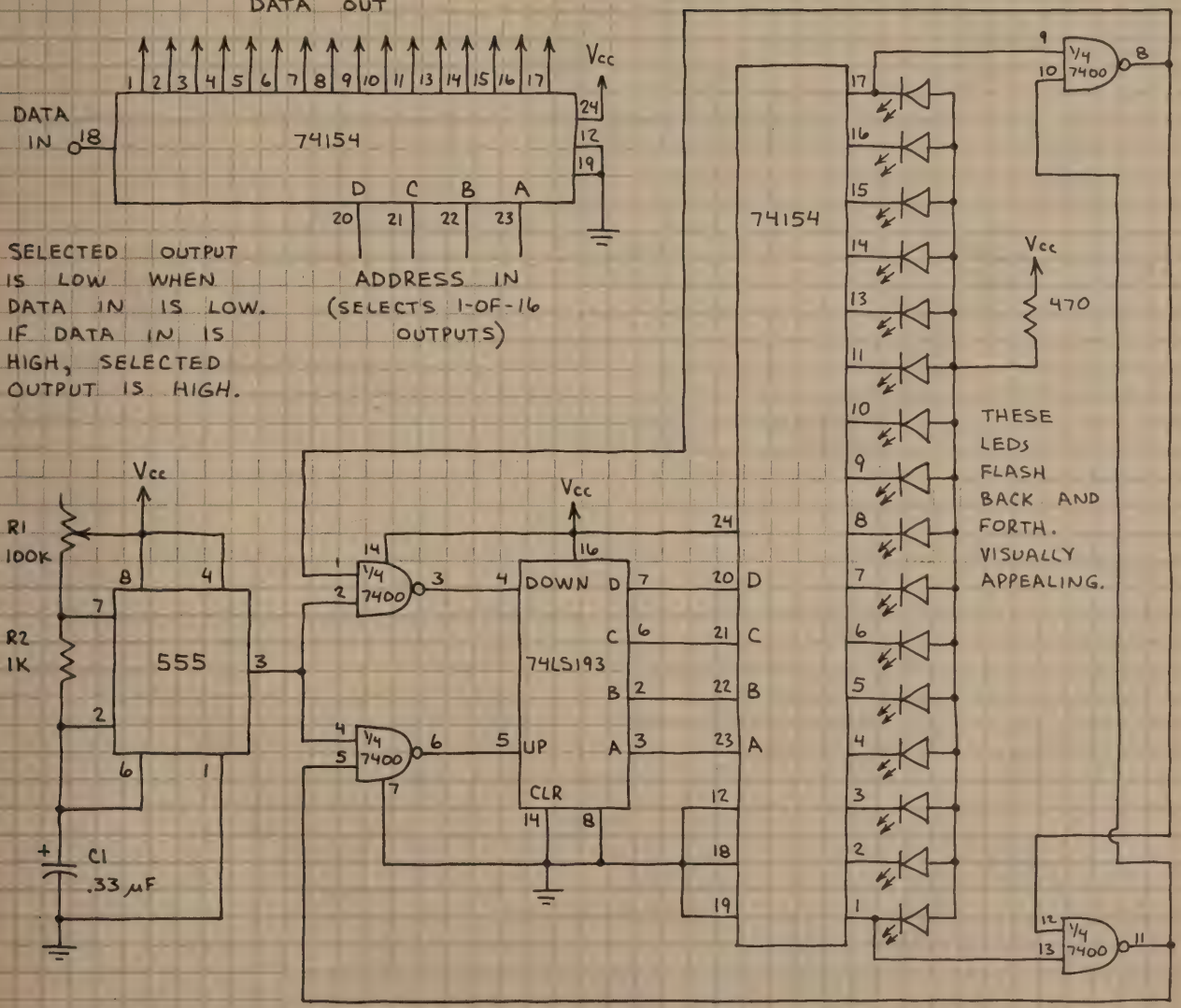
EACH 4-BIT ADDRESS DRIVES ONE OUTPUT LOW. ALL OTHERS STAY HIGH. ENABLE INPUTS (E1 AND E2) MUST BE LOW. IF ONE OR BOTH ARE HIGH, ALL OUTPUTS GO LOW.

1-TO-16 DEMULTIPLEXER

SELECTED OUTPUT IS LOW WHEN DATA IN IS LOW. IF DATA IN IS HIGH, SELECTED OUTPUT IS HIGH.

ADDRESS IN (SELECTS 1-OF-16 OUTPUTS)

BACK AND FORTH FLASHER

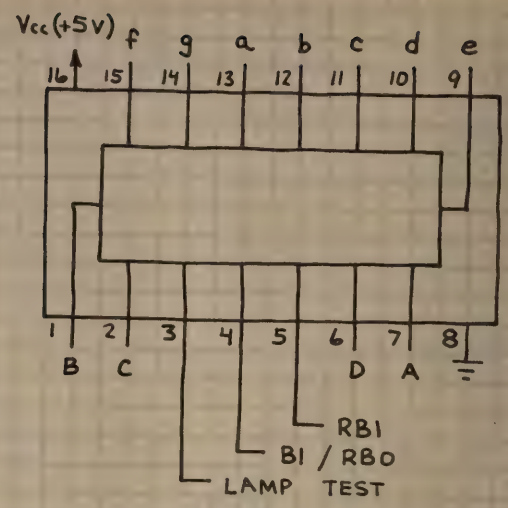


INCREASE R1 TO SLOW FLASH RATE.

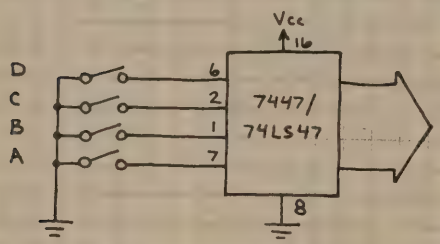
BCD-TO-7 SEGMENT DECODER / DRIVER

7447 / 74LS47

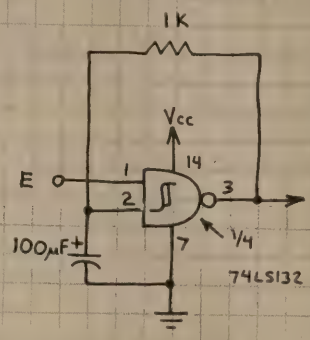
CONVERTS BCD DATA INTO FORMAT SUITABLE FOR PRODUCING DECIMAL DIGITS ON COMMON ANODE LED 7-SEGMENT DISPLAY. WHEN LAMP TEST INPUT IS LOW, ALL OUTPUTS ARE LOW (ON). WHEN BI/RBO (BLANKING INPUT) IS LOW, ALL OUTPUTS ARE HIGH (OFF). WHEN DCBA INPUT IS LLLL (DECIMAL 0) AND RBI (RIPPLE BLANKING INPUT) IS LOW, ALL OUTPUTS ARE HIGH (OFF). THIS PERMITS UNWANTED LEADING 0's IN A ROW OF DIGITS TO BE BLANKED.



MANUALLY SWITCHED DISPLAY



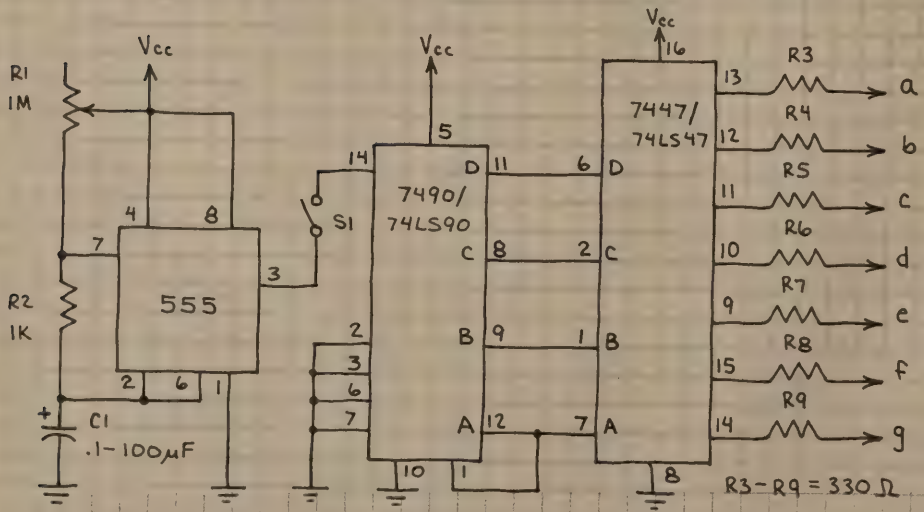
DISPLAY FLASHER

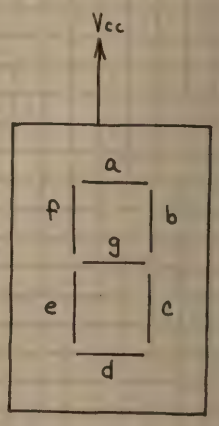


THIS SIMPLE CIRCUIT WILL FLASH DISPLAY TWICE PER SECOND.

E	DISPLAY
H	STEADY
L	FLASHES

0-9 SECOND / MINUTE TIMER



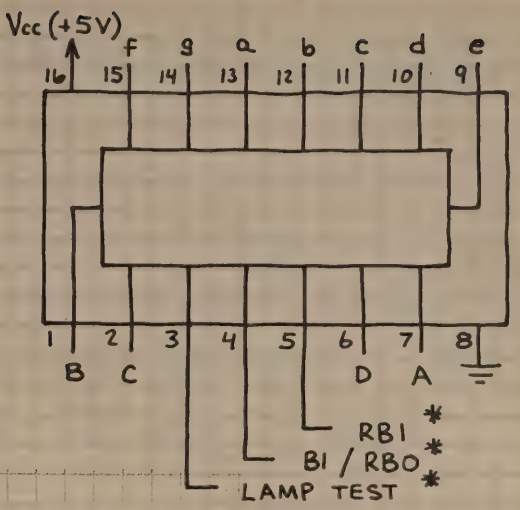


COMMON ANODE LED DISPLAY

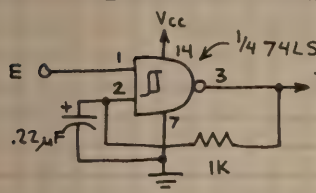
CLOSE S1 TO START TIMING CYCLE. CALIBRATE 555 FOR 1 PULSE (COUNT) PER SECOND OR 1 COUNT PER MINUTE BY ADJUSTING R1.

BCD-TO-7-SEGMENT DECODER/DRIVER 7448

CONVERTS BCD DATA INTO FORMAT SUITABLE FOR PRODUCING DECIMAL DIGITS ON COMMON CATHODE LED 7-SEGMENT DISPLAY.

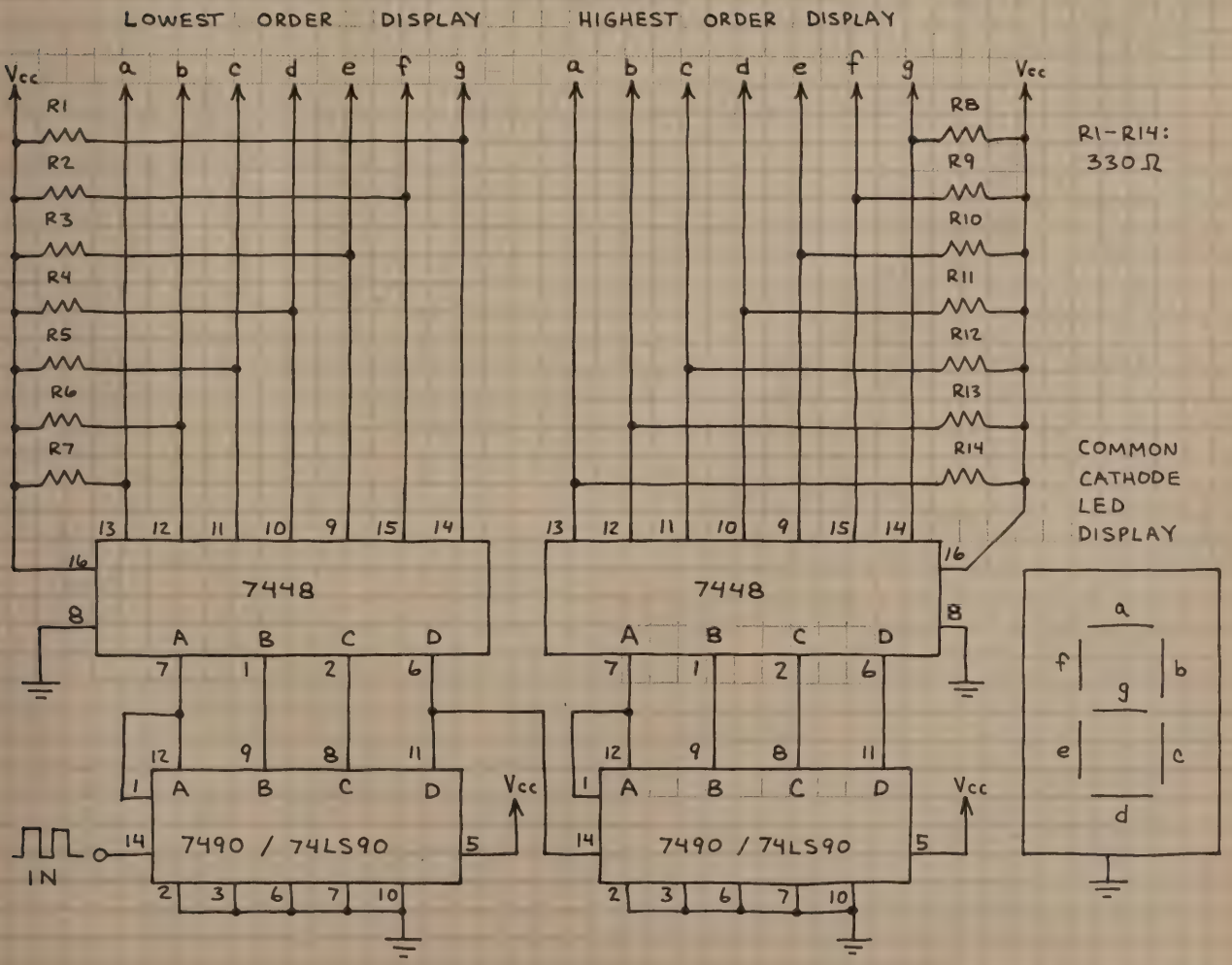


DISPLAY DIMMER



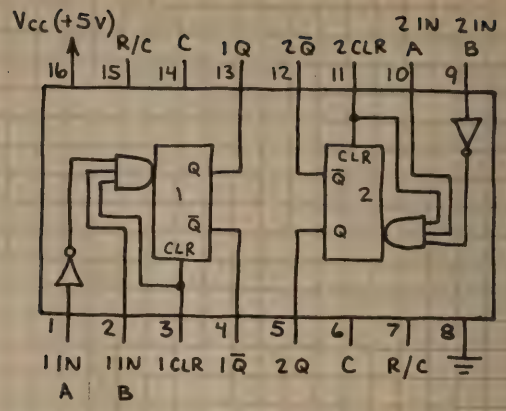
E	DISPLAY
H	NORMAL
L	DIM

0-99 TWO DIGIT COUNTER

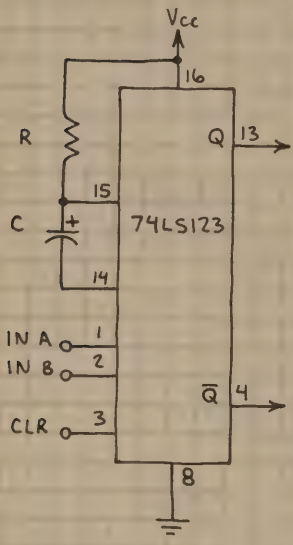


DUAL ONE-SHOT 74LS123

TWO FULLY INDEPENDENT MONOSTABLE MULTIVIBRATORS. BOTH ARE RETRIGGERABLE. PINS DESIGNATED R AND R/C ARE FOR EXTERNAL TIMING RESISTOR AND CAPACITOR. SEE RADIO SHACK DATA BOOK FOR INFORMATION ABOUT R AND C.



BASIC ONE-SHOT



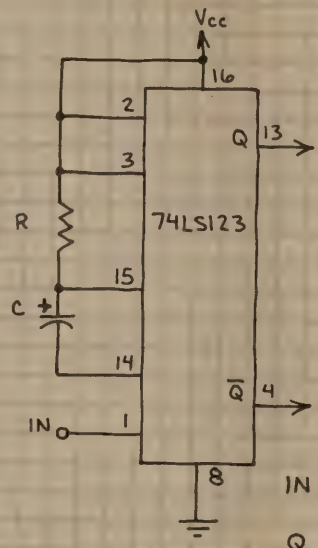
TWO WAYS TO TRIGGER:

1. KEEP INPUTS A AND B LOW; THEN MAKE B HIGH.
2. KEEP INPUTS A AND B HIGH; THEN MAKE A LOW.

TO CLEAR:

MAKE PIN 3 LOW. THIS ALSO INHIBITS TRIGGERING.

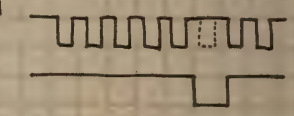
MISSING PULSE DETECTOR



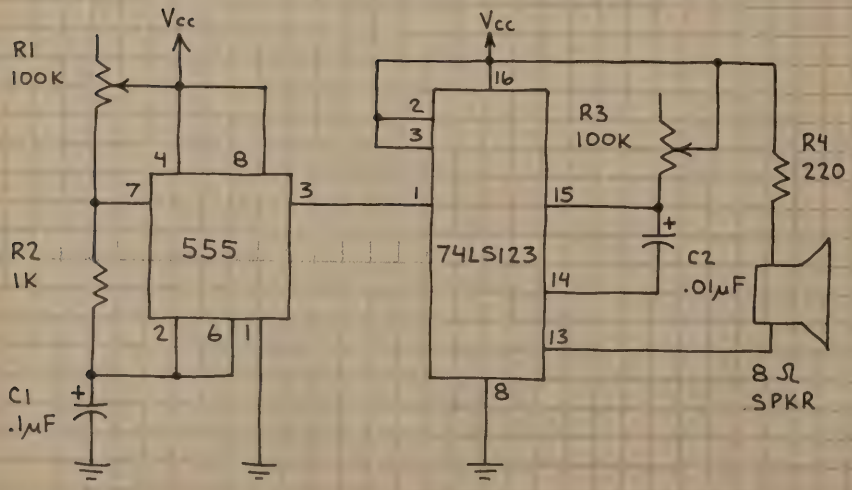
Q OUTPUT STAYS HIGH SO LONG AS INCOMING PULSES ARRIVE BEFORE ONE-SHOT TIMING PERIOD RUNS OUT.

ADJUST R AND C TO GIVE TIMING PERIOD ABOUT 1/3 LONGER THAN THE INTERVAL BETWEEN INCOMING PULSES.

OPERATION:



TONE STEPPER



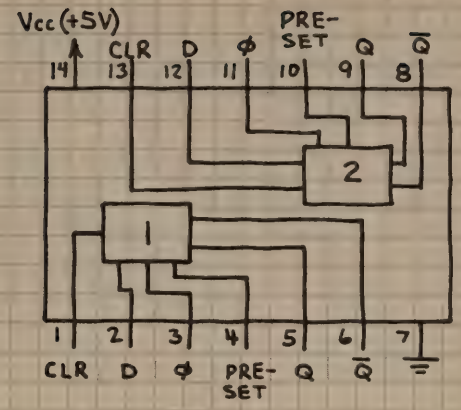
THIS CIRCUIT STEPS ACROSS A RANGE OF TONES WHEN R1 AND/OR R3 ARE ADJUSTED. VERY UNUSUAL SOUND EFFECTS.

CHANGE C1 AND C2 FOR OTHER TONE RANGES. ALSO, TRY PHOTORESISTORS FOR R1 AND R3.

DUAL D FLIP-FLOP 7474/74LS74

TWO D (DATA) FLIP-FLOPS IN A SINGLE PACKAGE. DATA AT D INPUT IS STORED AND MADE AVAILABLE AT Q OUTPUT WHEN CLOCK PULSE (ϕ) GOES HIGH. HERE'S THE TRUTH TABLE:

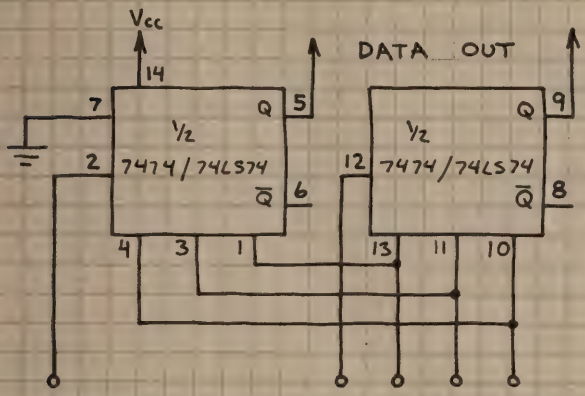
PRESET	CLEAR	CLOCK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
H	H	↑	H	H	L
H	H	↑	L	L	H



ϕ IS CLOCK INPUT.

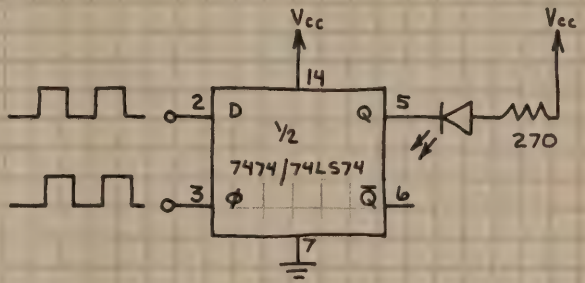
↑ IS RISING EDGE OF CLOCK PULSE.

2-BIT STORAGE REGISTER



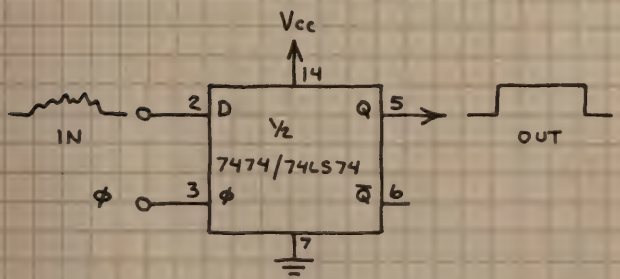
D ← DATA IN → D CLR ϕ PRESET

PHASE DETECTOR

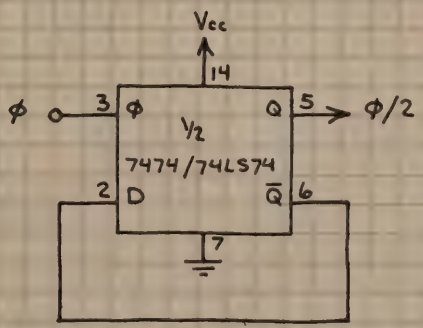


THE LED GLOWS WHEN INPUT FREQUENCIES F1 AND F2 ARE UNEQUAL OR OUT OF PHASE. F1 AND F2 SHOULD BE SQUARE WAVES.

WAVE SHAPER



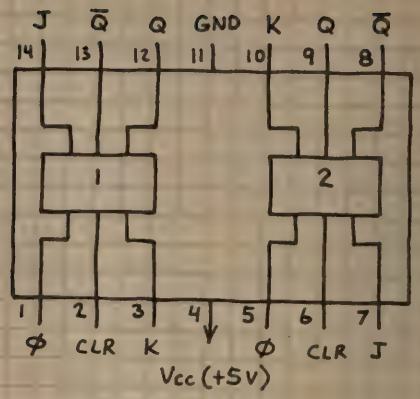
DIVIDE-BY-TWO COUNTER



DUAL J-K FLIP-FLOP
7473/74LS73

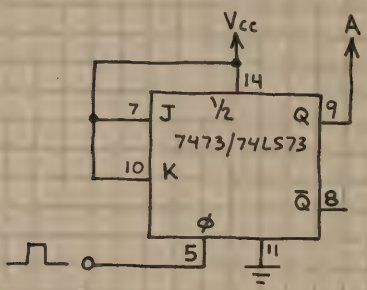
TWO JK FLIP-FLOPS IN A SINGLE PACKAGE. NOTE THE CLEAR INPUTS. THESE FLIP-FLOPS WILL TOGGLE (SWITCH OUTPUT STATES) IN RESPONSE TO INCOMING CLOCK PULSES WHEN BOTH J ANK J INPUTS ARE HIGH. HERE'S THE TRUTH TABLE:

CLEAR	CLOCK	J	K	Q	$\overline{Q}$
L	X	X	X	L	H
H	⎍	H	L	H	L
H	⎍	L	H	L	H
H	⎍	H	H	TOGGLE	



ϕ IS CLOCK INPUT.

DIVIDE-BY-TWO

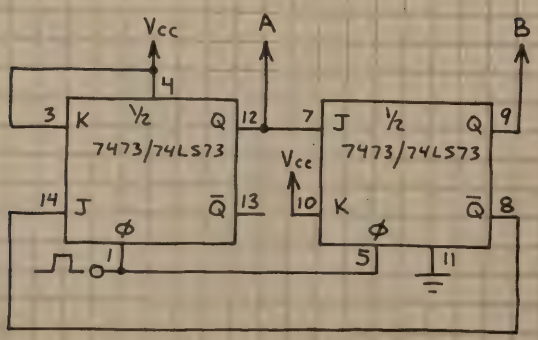


BINARY COUNTERS

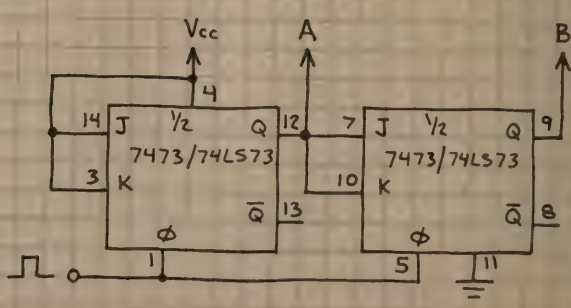
THE THREE CIRCUITS ON THIS PAGE ARE BINARY COUNTERS THAT COUNT UP TO THE MAXIMUM COUNT AND AUTOMATICALLY RECYCLE. CONNECT A DECODER TO OUTPUT OF DIVIDE-BY-THREE AND DIVIDE-BY-FOUR COUNTERS TO OBTAIN ONE-OF-THREE AND ONE-OF-FOUR OPERATION. THIS TRUTH TABLE SUMMARIZES OPERATION OF THESE COUNTERS:

DIVIDE-BY:	TWO	THREE		FOUR	
OUTPUTS:	A	B	A	B	A
	L	L	L	L	L
	H	L	H	L	H
		H	L	H	L
				H	H

DIVIDE-BY-THREE



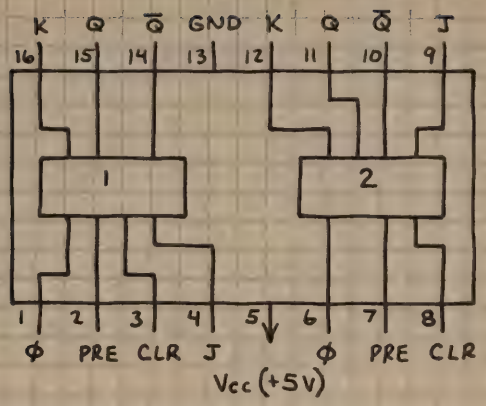
DIVIDE-BY-FOUR



DUAL J-K FLIP-FLOP
7476 / 74LS76

TWO JK FLIP-FLOPS IN A SINGLE PACKAGE. SIMILAR TO 7473/74LS73 BUT HAS BOTH PRESET AND CLEAR INPUTS. FLIP-FLOPS WILL TOGGLE (SWITCH OUTPUT STATES) IN RESPONSE TO INCOMING CLOCK PULSES WHEN BOTH J AND K INPUTS ARE HIGH. HERE'S THE TRUTH TABLE:

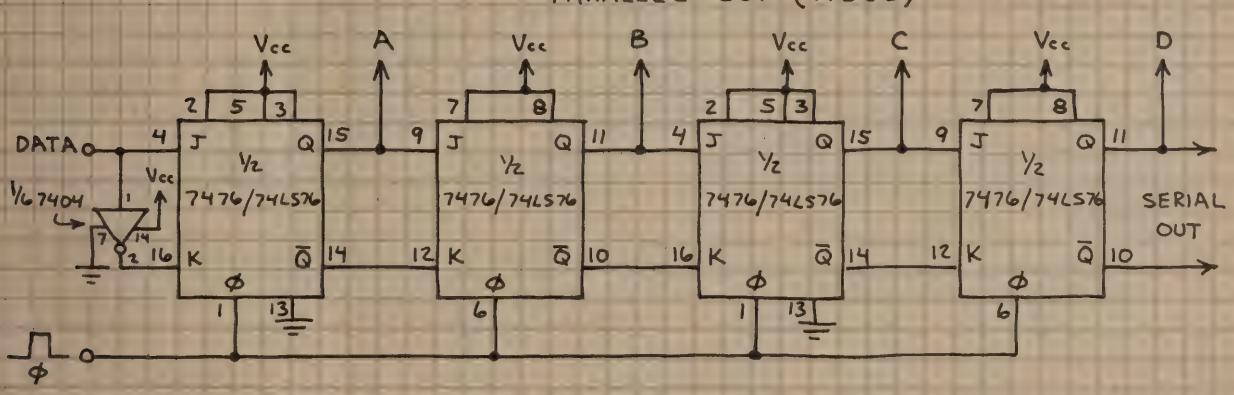
PRE	CLR	CLK	J	K	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
H	H	⎍	H	L	H	L
H	H	⎍	L	H	L	H
H	H	⎍	H	H	TOGGLE	



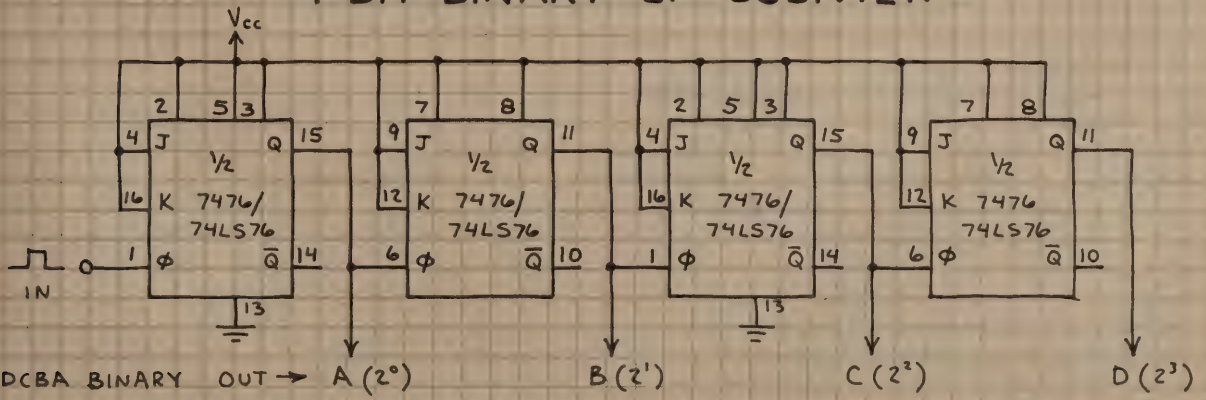
PRE = PRESET
CLR = CLEAR
Φ = CLOCK (OR CLK)

TOGGLE = FLIP-FLOP SWITCHES OUTPUT STATES IN RESPONSE TO CLOCK PULSES.

4-BIT SERIAL SHIFT REGISTER

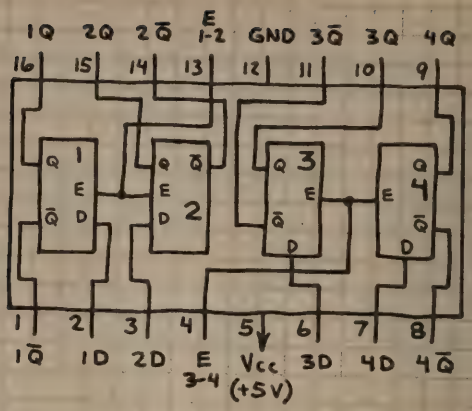


4-BIT BINARY UP COUNTER



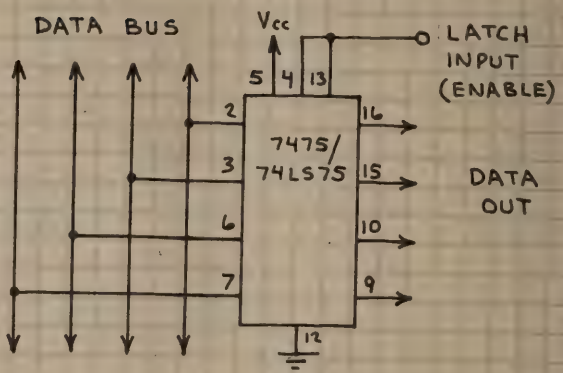
QUAD LATCH
7475/74LS75

A 4-BIT BISTABLE LATCH. PRIMARILY USED TO STORE THE COUNT IN DECIMAL COUNTING UNITS. NOTE THAT BOTH Q AND $\bar{Q}$ OUTPUTS ARE PROVIDED. ALSO NOTE THE E (ENABLE) INPUTS. WHEN E IS HIGH, Q FOLLOWS D.

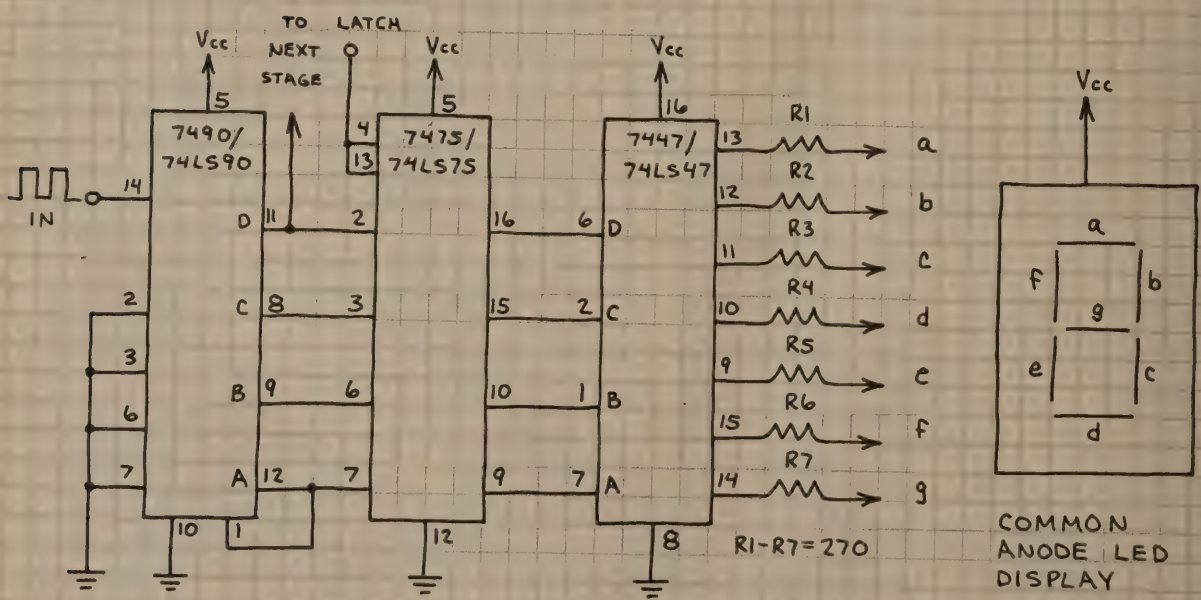


4-BIT DATA LATCH

DATA ON BUS APPEARS AT OUTPUTS WHEN LATCH INPUT IS HIGH. DATA ON BUS WHEN LATCH INPUT GOES LOW IS STORED UNTIL LATCH INPUT GOES HIGH. (LATCH INPUT CONTROLS BOTH ENABLE INPUTS) TWO QUAD LATCHES CAN BE USED AS AN 8-BIT DATA LATCH.



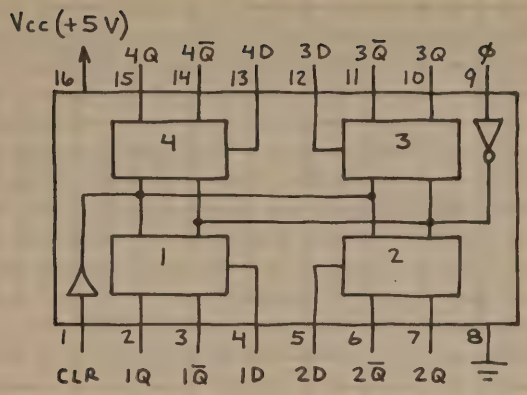
DECIMAL COUNTING UNIT

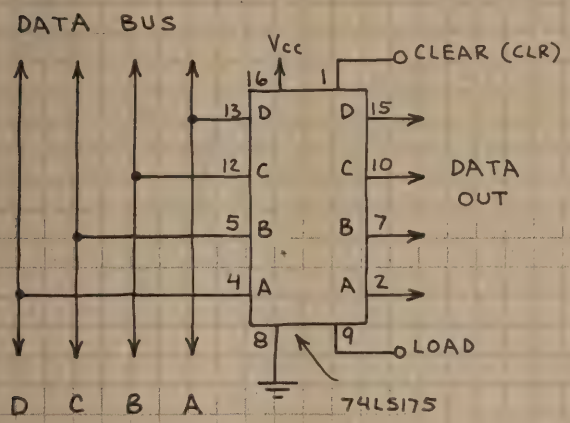


EXPANDABLE DECADE COUNTER. FOR TWO DIGIT COUNT, CONNECT PIN 11 OF 7490/74LS90 OF FIRST UNIT TO INPUT OF SECOND UNIT. A LOW AT THE LATCH INPUT FREEZES THE DATA BEING DISPLAYED.

QUAD D FLIP-FLOP 74LS175

HANDY PACKAGE OF FOUR D-TYPE FLIP-FLOPS. DATA AT D-INPUTS IS LOADED WHEN CLOCK GOES HIGH. MAKING CLEAR INPUT LOW MAKES ALL Q OUTPUTS LOW AND $\bar{Q}$ OUTPUTS HIGH.

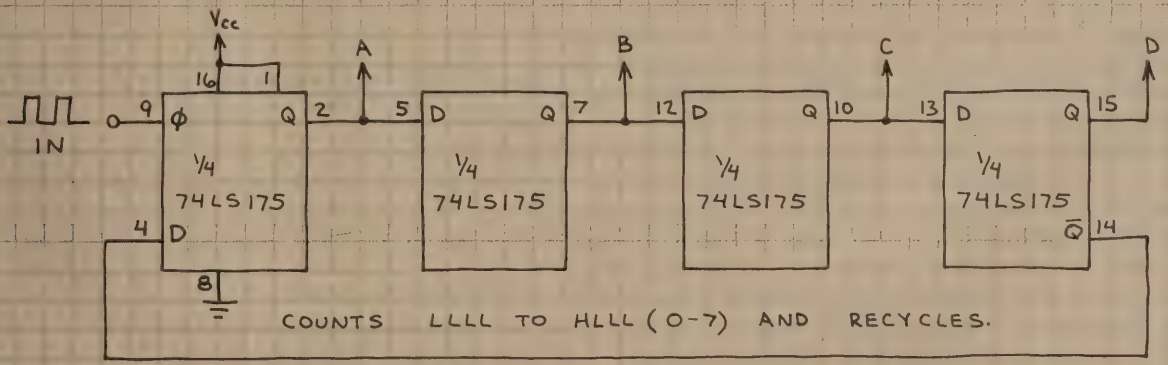




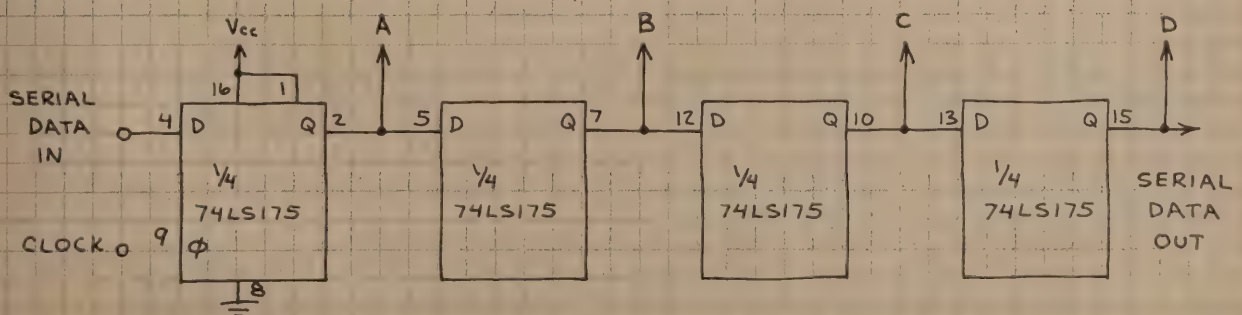
4-BIT DATA REGISTER

DATA ON BUS IS LOADED INTO 74LS175 WHEN LOAD INPUT GOES HIGH. DATA IS THEN STORED AND MADE AVAILABLE AT OUTPUTS UNTIL NEW LOAD PULSE ARRIVES.

MODULO-8 COUNTER

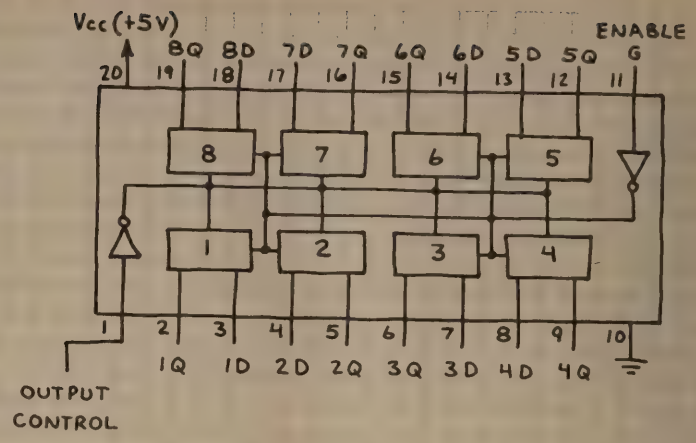


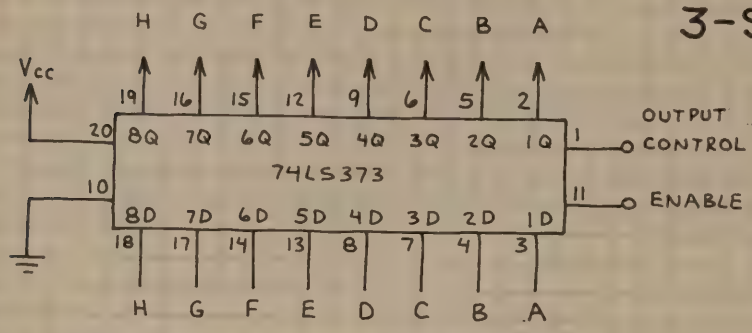
SERIAL IN/OUT, PARALLEL OUT SHIFT REGISTER



OCTAL D-TYPE LATCH 74LS373

EIGHT "TRANSPARENT" D-TYPE LATCHES. OUTPUT FOLLOWS INPUT WHEN ENABLE IS HIGH. THE DATA AT THE INPUTS IS LOADED WHEN THE ENABLE INPUT IS LOW. THIS CHIP HAS 3-STATE OUTPUTS WHICH ARE CONTROLLED BY PIN 1. SEE TRUTH TABLE BELOW.




H G F E D C B A
Vcc
19 16 15 12 9 6 5 2
20 8Q 7Q 6Q 5Q 4Q 3Q 2Q 1Q 1
74LS373
10 8D 7D 6D 5D 4D 3D 2D 1D 11
18 17 14 13 8 7 4 3
H G F E D C B A
OUTPUT CONTROL
ENABLE

3-STATE REGISTER

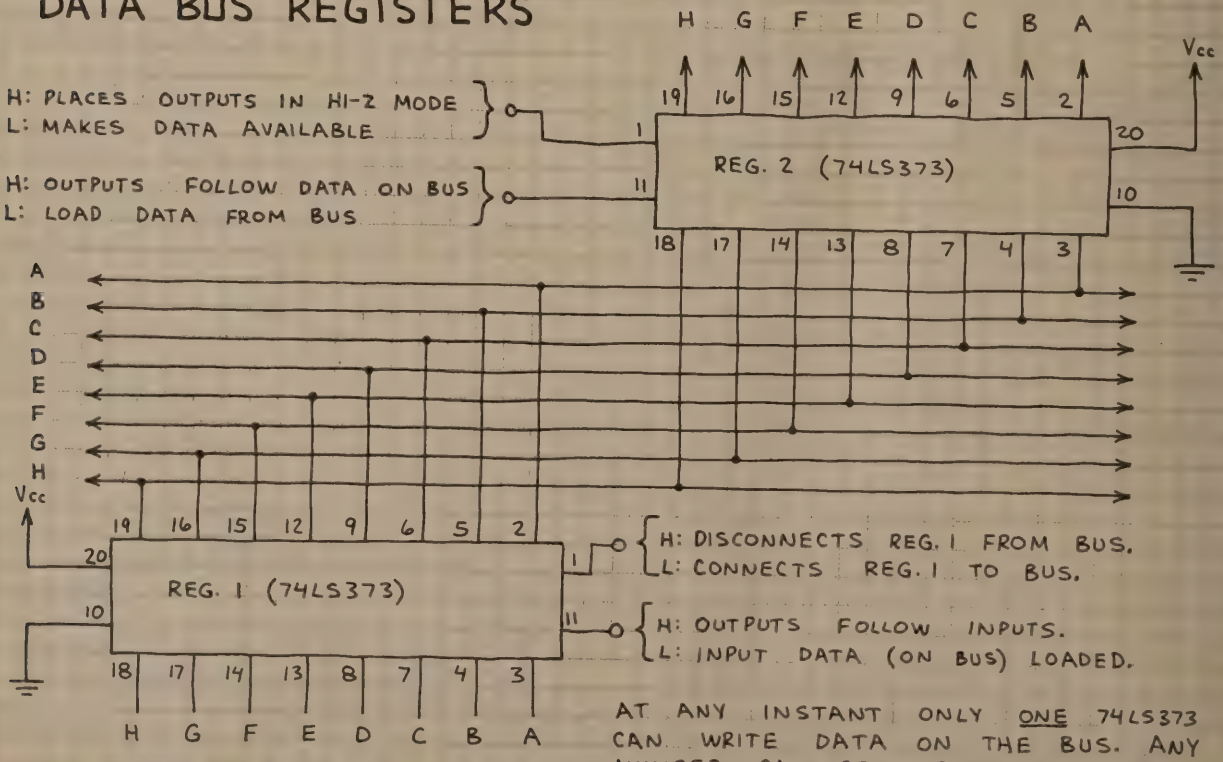
THIS IS A GENERAL PURPOSE 8-BIT STORAGE REGISTER. HERE'S THE TRUTH TABLE:

OUTPUT CONTROL	ENABLE	D	Q
L	H	H	H
L	H	L	L
L	L	X	Q
H	X	X	HI-Z

DATA BUS REGISTERS

H: PLACES OUTPUTS IN HI-Z MODE
L: MAKES DATA AVAILABLE

H: OUTPUTS FOLLOW DATA ON BUS
L: LOAD DATA FROM BUS



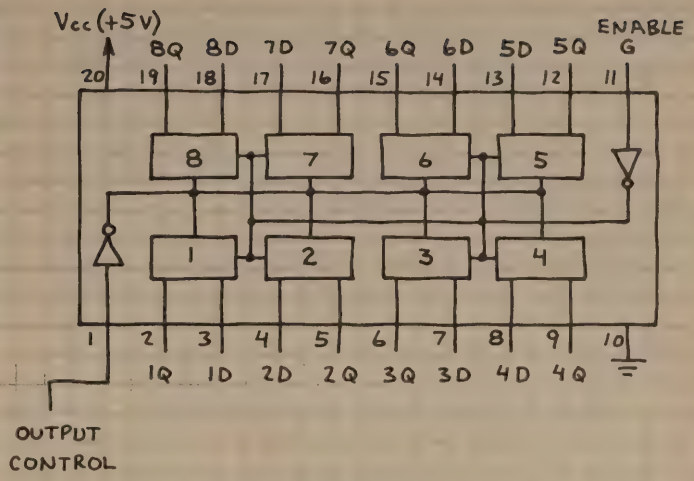
H: DISCONNECTS REG. 1 FROM BUS.
L: CONNECTS REG. 1 TO BUS.

H: OUTPUTS FOLLOW INPUTS.
L: INPUT DATA (ON BUS) LOADED.

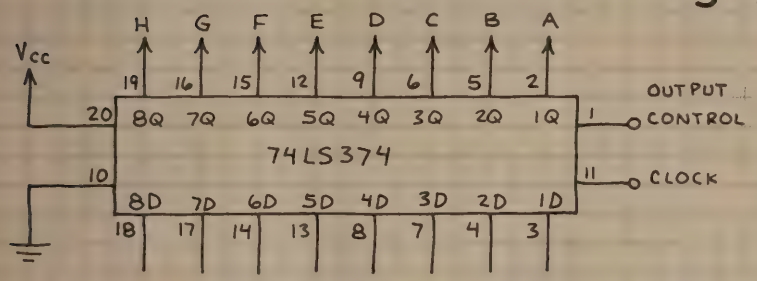
AT ANY INSTANT ONLY ONE 74LS373 CAN WRITE DATA ON THE BUS. ANY NUMBER CAN READ DATA FROM BUS.

OCTAL D FLIP-FLOP
74LS374

EIGHT D-TYPE EDGE TRIGGERED FLIP-FLOPS. UNLIKE 74LS373, OUTPUTS DO NOT FOLLOW INPUTS. INSTEAD, A RISING CLOCK PULSE AT PIN 11 LOADS DATA APPEARING AT INPUTS. THIS CHIP HAS 3-STATE OUTPUTS WHICH ARE CONTROLLED BY PIN 1.



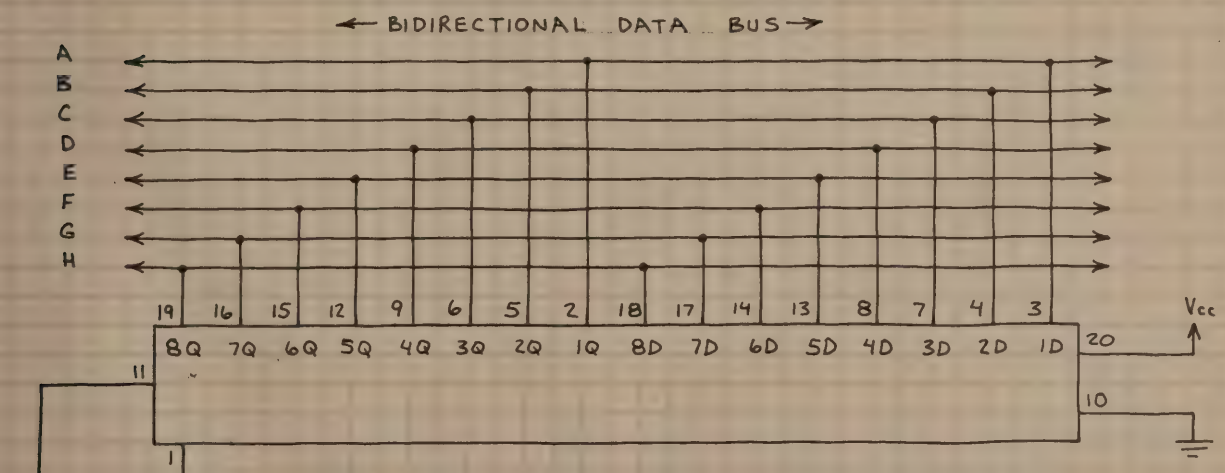
CLOCKED 3-STATE REGISTER


H G F E D C B A
Vcc
19 16 15 12 9 6 5 2
20 8Q 7Q 6Q 5Q 4Q 3Q 2Q 1Q 1
74LS374
10 11
8D 7D 6D 5D 4D 3D 2D 1D
18 17 14 13 8 7 4 3
H G F E D C B A
OUTPUT CONTROL
CLOCK

GENERAL PURPOSE CLOCKED REGISTER. HERE'S THE TRUTH TABLE:

OUTPUT CONTROL	CLOCK	D	Q
L	⎍	H	H
L	⎍	L	L
L	H	X	Q
H	X	X	HI-Z

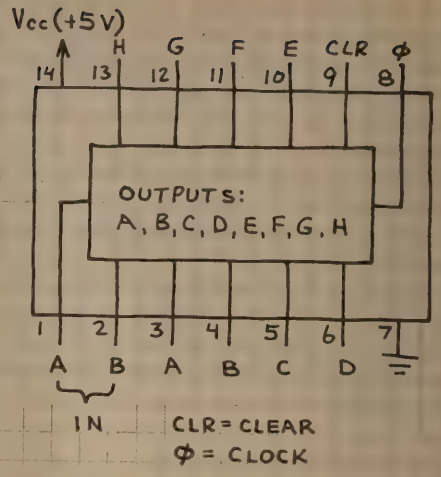
COMMON INPUT/OUTPUT BUS REGISTER



THIS CIRCUIT GIVES 74LS374 COMMON INPUT AND OUTPUT LINES. WHEN OUTPUT CONTROL IS HIGH, DATA ON BUS IS LOADED INTO THE 74LS374 ON THE RISING EDGE (⎍) OF THE CLOCK PULSE. WHEN OUTPUT CONTROL IS LOW, DATA IN THE 74LS374 IS WRITTEN ONTO THE BUS.

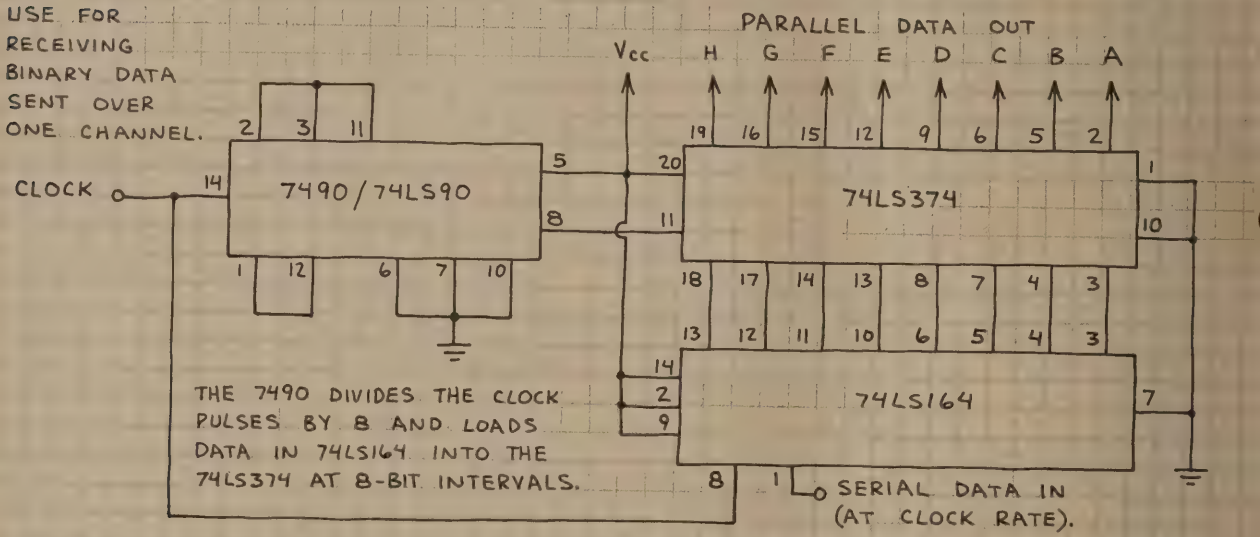
8-BIT SHIFT REGISTER
74LS164

DATA AT ONE OF THE TWO SERIAL INPUTS IS ADVANCED ONE BIT FOR EACH CLOCK PULSE. DATA CAN BE EXTRACTED FROM THE 8 PARALLEL OUTPUTS OR IN SERIAL FORM AT ANY SINGLE OUTPUT. ENTER DATA AT EITHER INPUT. THE UNUSED INPUT MUST BE HELD HIGH OR CLOCKING WILL BE INHIBITED. MAKING PIN 9 LOW CLEARS THE REGISTER TO LLLL.

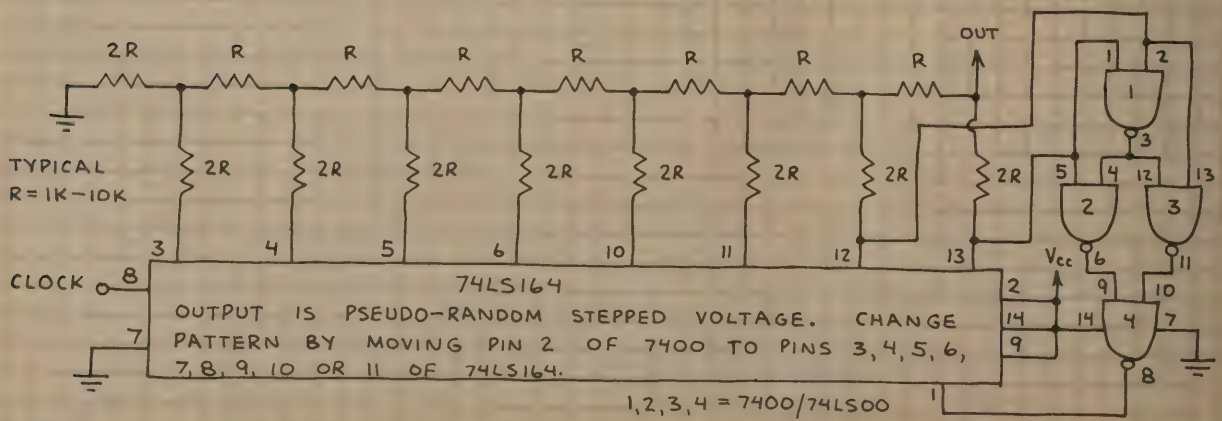


8-BIT SERIAL-TO-PARALLEL DATA CONVERTER

USE FOR RECEIVING BINARY DATA SENT OVER ONE CHANNEL.

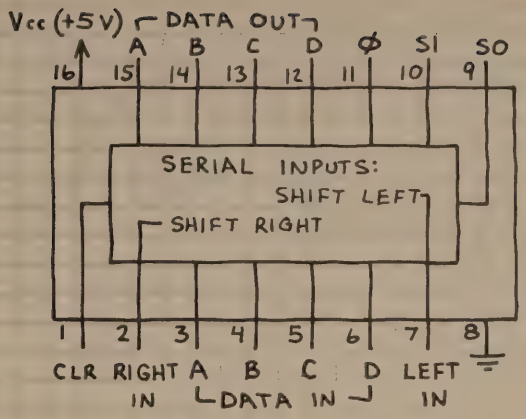


PSEUDO-RANDOM VOLTAGE GENERATOR

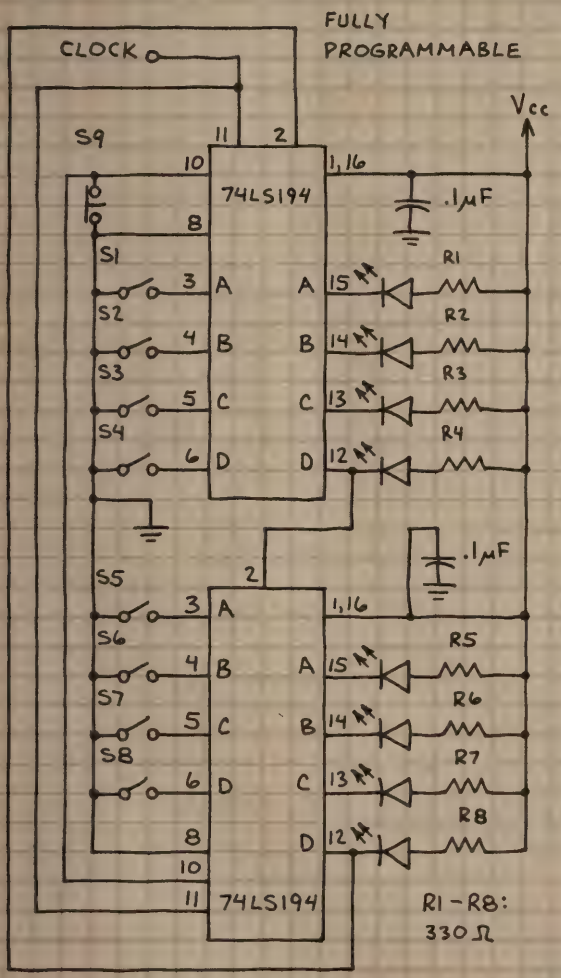


4-BIT SHIFT REGISTER 74LS194

BIDIRECTIONAL UNIVERSAL SHIFT REGISTER. SHIFTS RIGHT WHEN SO IS HIGH AND SI IS LOW. SHIFTS LEFT WHEN SO IS LOW AND SI IS HIGH. SHIFTS ONE POSITION PER CLOCK PULSE. LOADS DATA AT INPUTS WHEN SO AND SI ARE HIGH. IMPORTANT: BYPASS POWER SUPPLY PINS WITH 0.1 μF CAPACITOR!



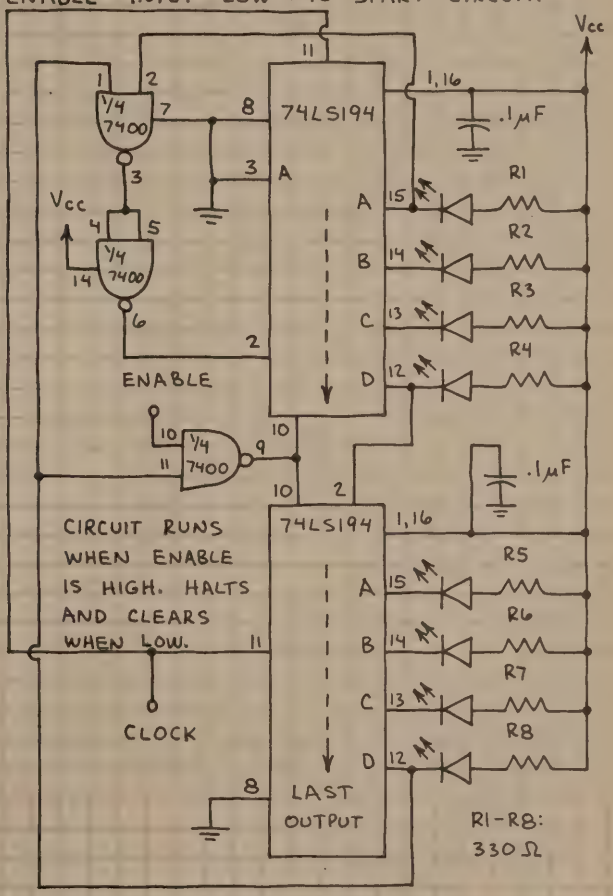
SEQUENCE GENERATOR



LOAD ANY DESIRED BIT PATTERN INTO SI-SB (OPEN = HIGH AND CLOSED = LOW). PRESS S9 (NORMALLY CLOSED) TO LOAD. DATA WILL MOVE RIGHT ONE OUTPUT PER CLOCK PULSE. LEDs ARE OPTIONAL.

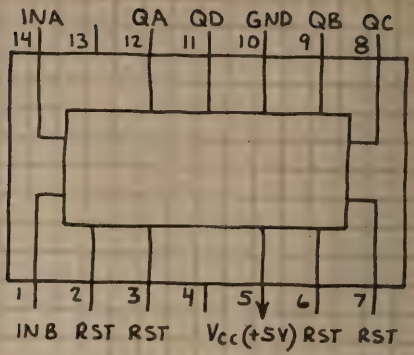
BARGRAPH GENERATOR

WHEN POWER IS FIRST APPLIED, MAKE ENABLE INPUT LOW TO START CIRCUIT.



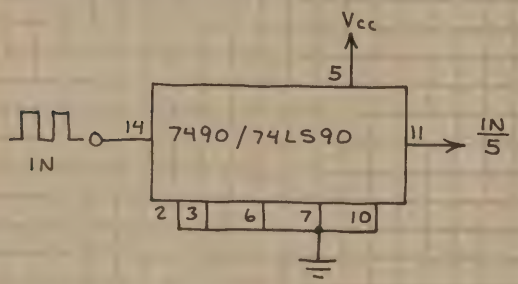
OUTPUTS GO LOW AND STAY LOW ONE AT A TIME FROM LEFT TO RIGHT (A→D) IN SEQUENCE WITH CLOCK. WHEN FINAL OUTPUT GOES LOW, ALL OUTPUTS BUT THE FIRST GO HIGH AND RECYCLE.

BCD (DECADE) COUNTER
7490/74LS90

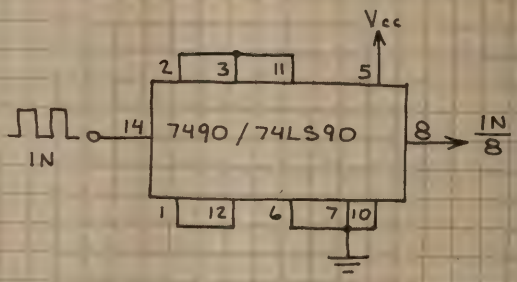


ONE OF THE MOST POPULAR DECADE COUNTERS. EASILY USED FOR DIVIDE-BY-N COUNTERS. LESS EXPENSIVE THAN MORE SOPHISTICATED COUNTERS. RST INDICATES RESET PINS. THIS CHIP IS USUALLY USED IN DECIMAL COUNTING UNITS, BUT CIRCUITS ON THIS PAGE SHOW MANY OTHER POSSIBILITIES.

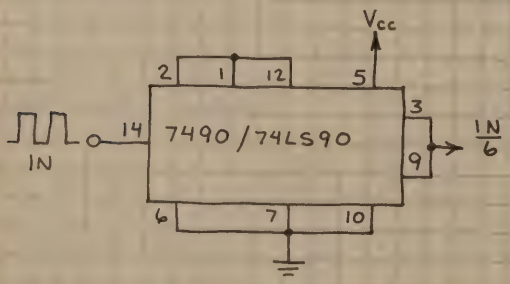
DIVIDE-BY-5 COUNTER



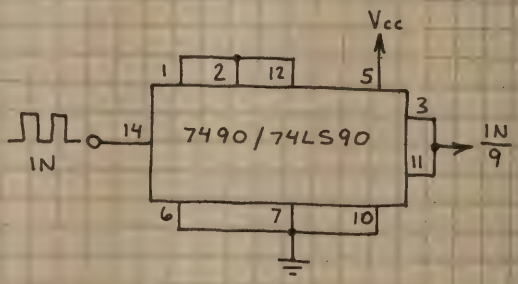
DIVIDE-BY-8 COUNTER



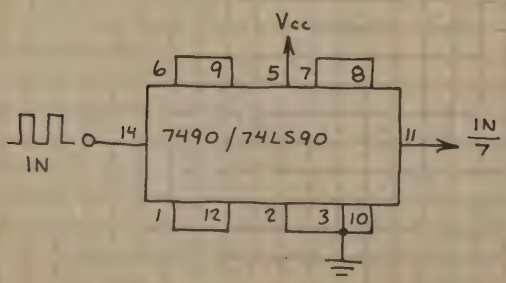
DIVIDE-BY-6 COUNTER



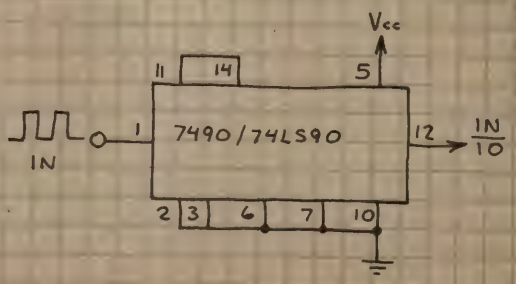
DIVIDE-BY-9 COUNTER



DIVIDE-BY-7 COUNTER

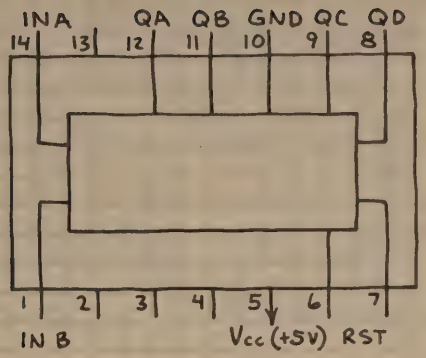


DIVIDE-BY-10 COUNTER

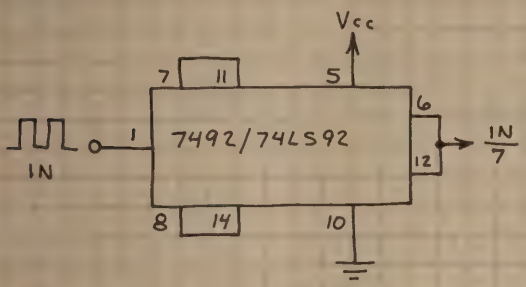


DIVIDE-BY-12 BINARY COUNTER
7492/74LS92

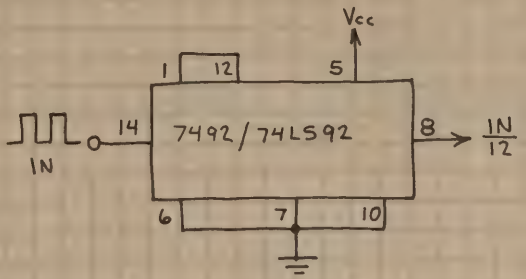
OFTEN USED TO DIVIDE CONDITIONED 60 HZ PULSES FROM AC POWER LINE INTO 10 HZ PULSES. OTHER DIVIDER APPLICATIONS ALSO. RST INDICATES RESET PINS.



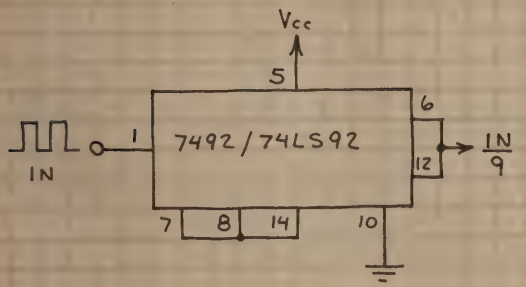
DIVIDE-BY-7 COUNTER



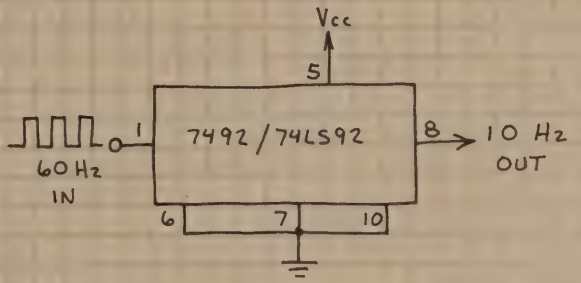
DIVIDE-BY-12 COUNTER



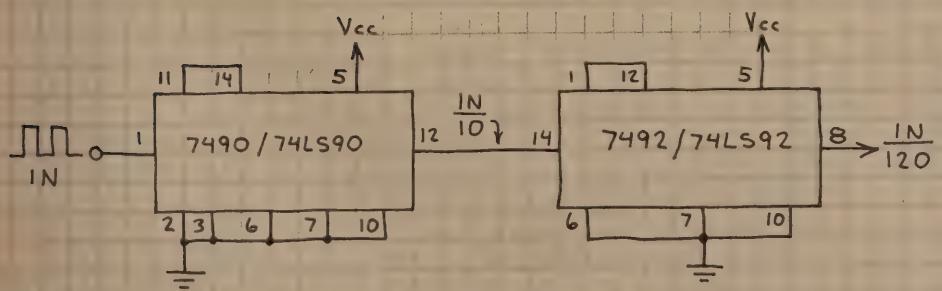
DIVIDE-BY-9 COUNTER



10-HZ PULSE SOURCE



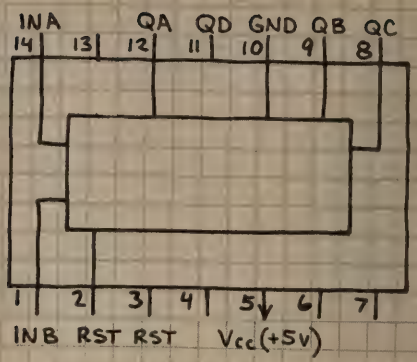
DIVIDE-BY-120 COUNTER



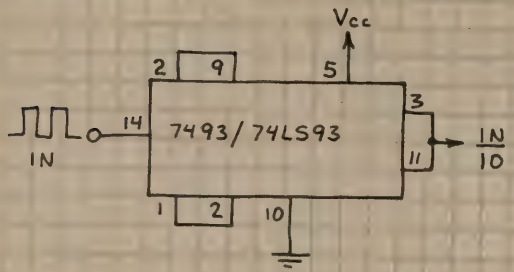
THIS METHOD OF CASCADING COUNTERS CAN BE USED TO CREATE ANY DIVIDE-BY-N COUNTER.

4-BIT (BINARY) COUNTER
7493 / 74LS93

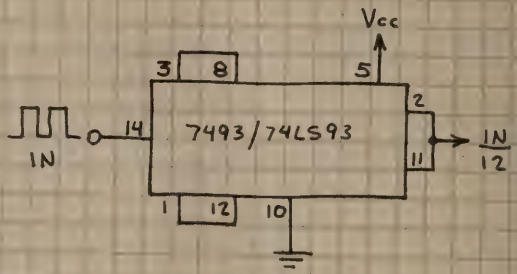
EASY TO USE 4-BIT BINARY COUNTER. LESS EXPENSIVE THAN MORE SOPHISTICATED COUNTERS. RST INDICATES RESET PINS. NOTE UNUSUAL LOCATION OF POWER SUPPLY PINS.



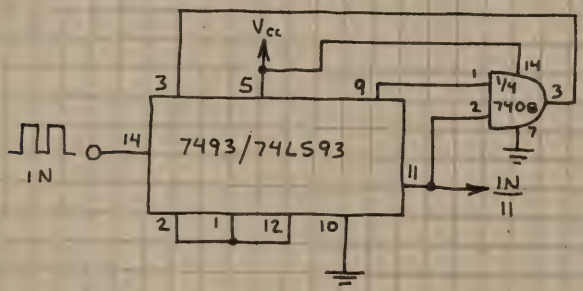
DIVIDE-BY-10 COUNTER



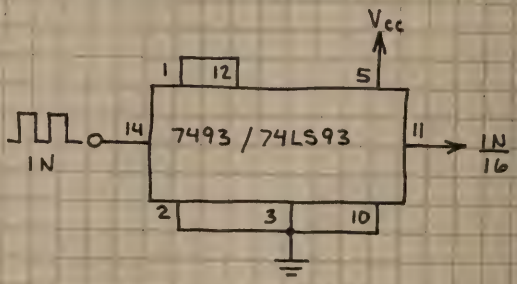
DIVIDE-BY-12 COUNTER



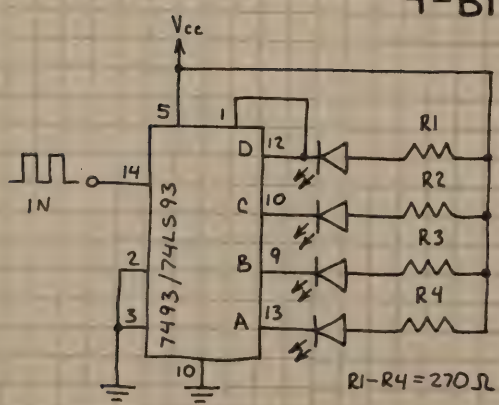
DIVIDE-BY-11 COUNTER



DIVIDE-BY-16 COUNTER



4-BIT BINARY COUNTER

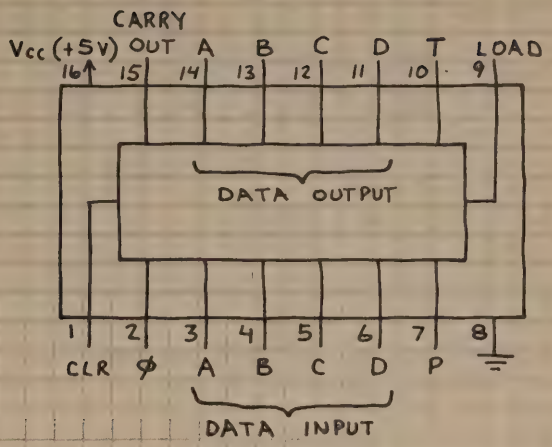


COUNTS FROM 0-15 IN BINARY AND RECYCLES. GLOWING LED = L (0); OFF LED = H (1). 555 TIMER IC MAKES GOOD INPUT CLOCK.

TRUTH TABLE

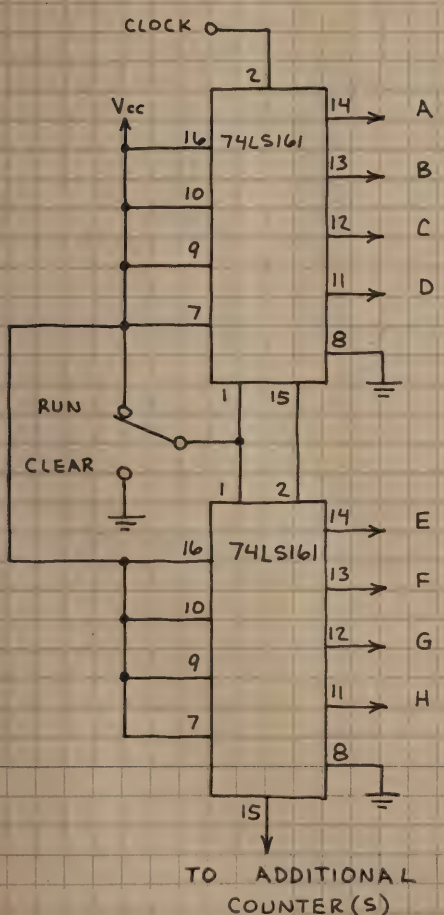
D C B A	D C B A
L L L L	H L L L
L L L H	H L L H
L L H L	H L H L
L L H H	H L H H
L H L L	H H L L
L H L H	H H L H
L H H L	H H H L
L H H H	H H H H

4-BIT UP COUNTER
74LS161



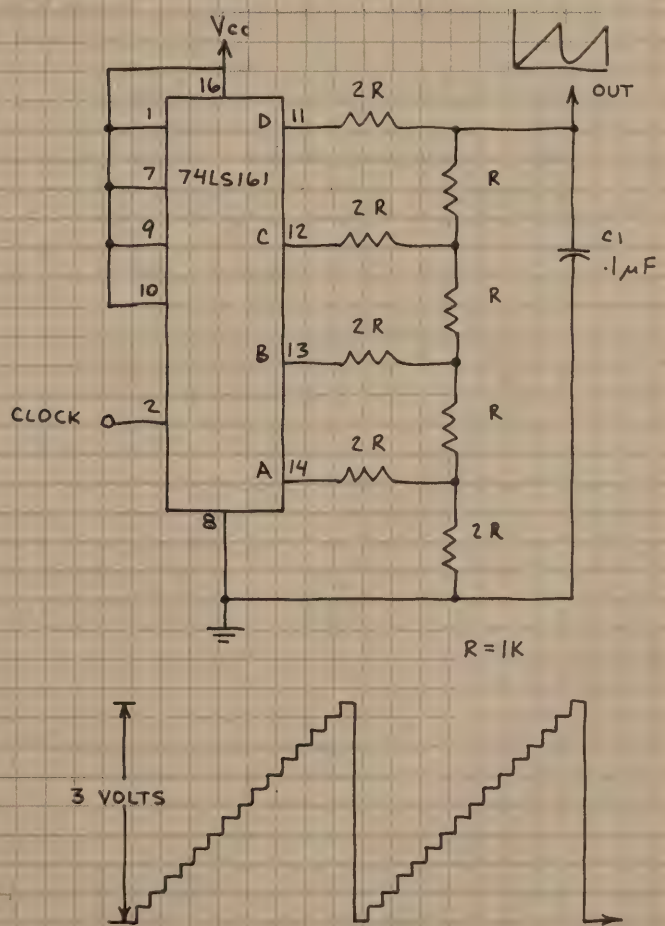
GENERAL PURPOSE BINARY COUNTER WITH PROGRAMMABLE INPUTS. COUNTER ACCEPTS DATA AT INPUTS WHEN LOAD INPUT GOES LOW. A LOW AT THE CLEAR INPUT RESETS THE COUNTER TO LLLL UPON THE NEXT CLOCK PULSE. P AND T ARE COUNT ENABLE INPUTS. BOTH P AND T MUST BE HIGH TO COUNT. THESE ENABLE INPUTS ARE NOT AVAILABLE WITH THE OTHERWISE MORE ADVANCED 74LS193.

8-BIT COUNTER



OUTPUT A IS LOWEST ORDER BIT.

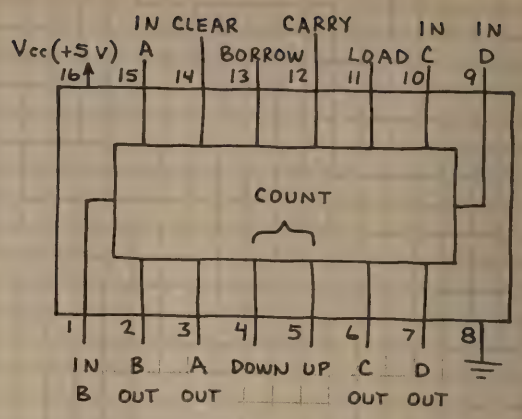
RAMP SYNTHESIZER



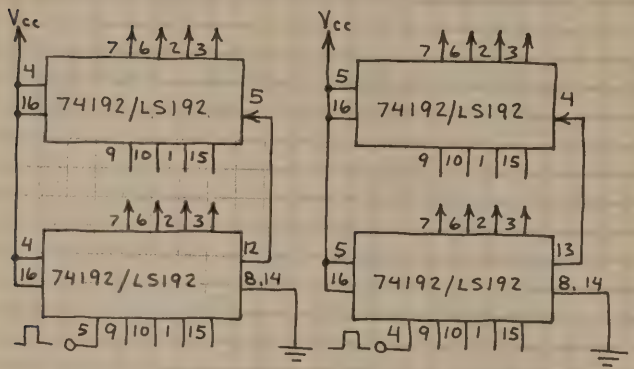
REMOVE C1 TO OBTAIN THIS STAIRCASE. FREQUENCY OF RAMP AND STAIRCASE IS 1/16 CLOCK FREQUENCY.

BCD UP-DOWN COUNTER
74192/74LS192

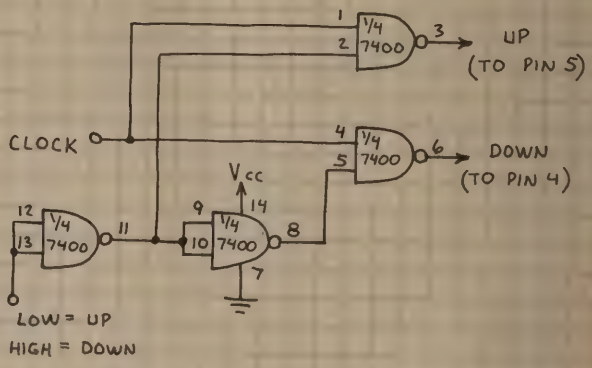
FULLY PROGRAMMABLE BCD COUNTER. OPERATION IS IDENTICAL TO 74193/74LS193 EXCEPT COUNT IS 10-STEP BCD (LLLL-HLLH) INSTEAD OF 16-STEP BINARY. MANY APPLICATIONS FOR 74192/74LS192 AND 74193/74LS193 ARE INTERCHANGEABLE.



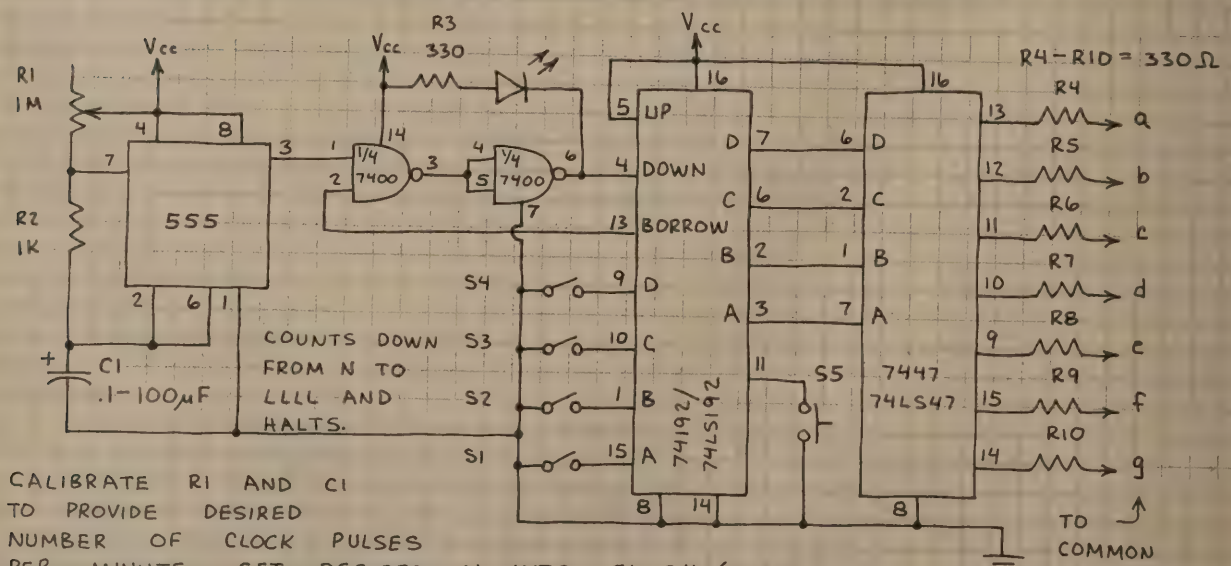
CASCADED COUNTERS



SINGLE UP-DOWN INPUT



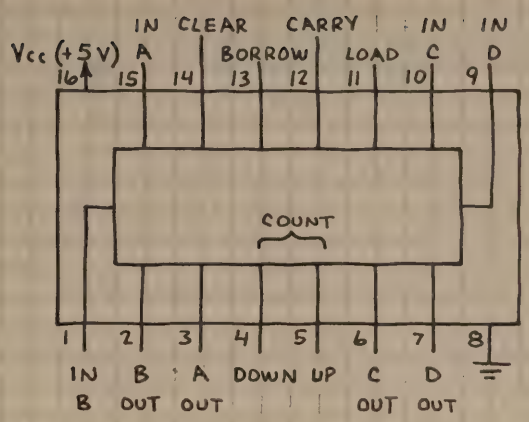
PROGRAMMABLE COUNT DOWN TIMER

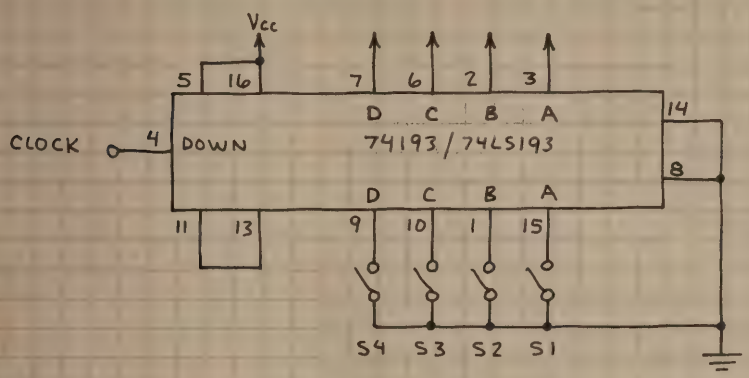


CALIBRATE R1 AND C1 TO PROVIDE DESIRED NUMBER OF CLOCK PULSES PER MINUTE. SET DESIRED N INTO S1-S4 (CLOSED SWITCH = LOW AND OPEN SWITCH = HIGH). PRESS S5 TO LOAD N AND START (OR RESET) COUNT. LED GLOWS AT HALT.

4-BIT UP-DOWN COUNTER 74193/74LS193

VERY VERSATILE 4-BIT COUNTER WITH UP-DOWN CAPABILITY. ANY 4-BIT NUMBER AT THE DCBA INPUTS IS LOADED INTO THE COUNTER WHEN THE LOAD INPUT (PIN 11) IS MADE LOW. THE COUNTER IS CLEARED TO LLLL WHEN THE CLEAR INPUT (PIN 14) IS MADE HIGH. THE BORROW AND CARRY OUTPUTS INDICATE UNDERFLOW OR OVERFLOW BY GOING LOW.



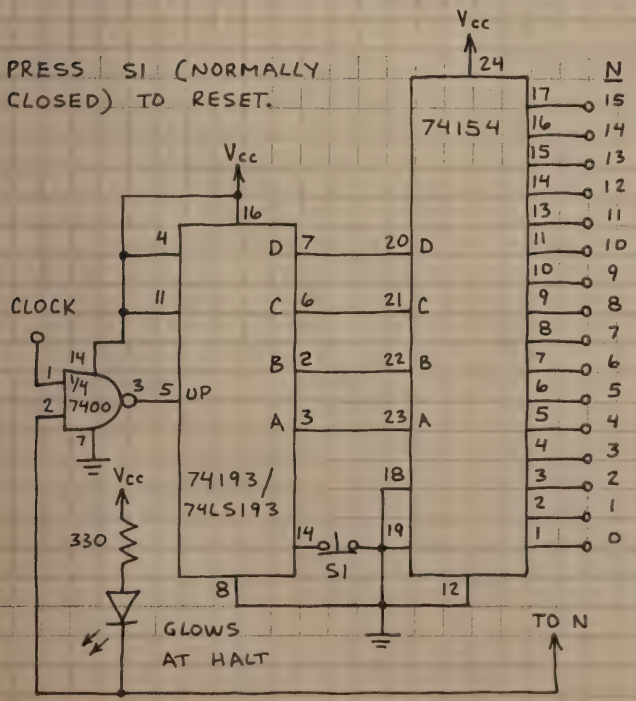


COUNT DOWN FROM N AND RECYCLE

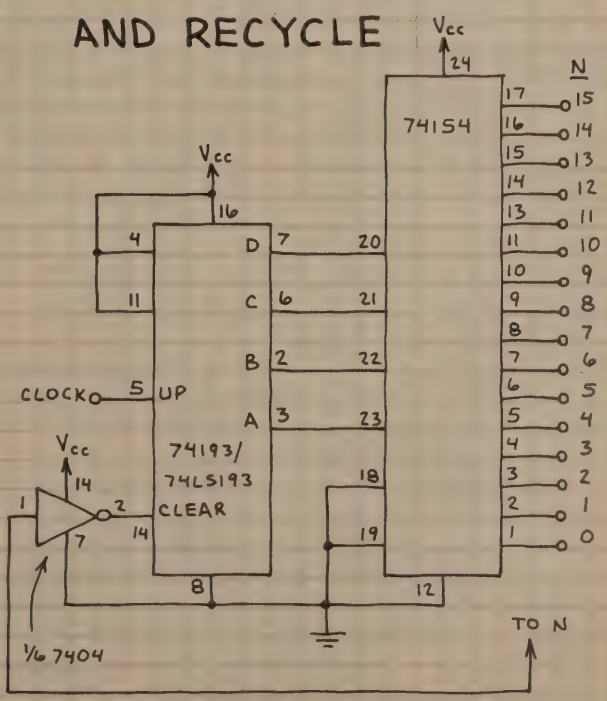
SET DESIRED N INTO S1-S4 (CLOSED SWITH = LOW AND OPEN SWITCH = HIGH). WHEN COUNT REACHES LLLL AND THEN UNDERFLOWS, THE BORROW PULSE LOADS N AND THE COUNT RECYCLES.

COUNT UP TO N AND HALT

PRESS S1 (NORMALLY CLOSED) TO RESET.

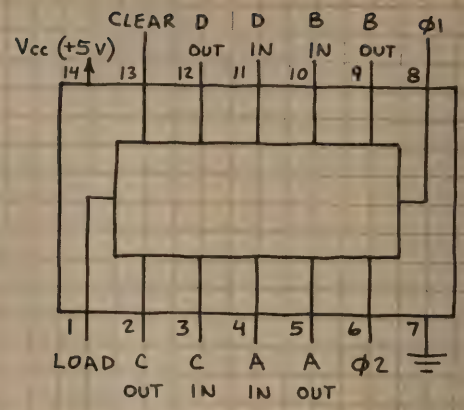


COUNT UP TO N AND RECYCLE

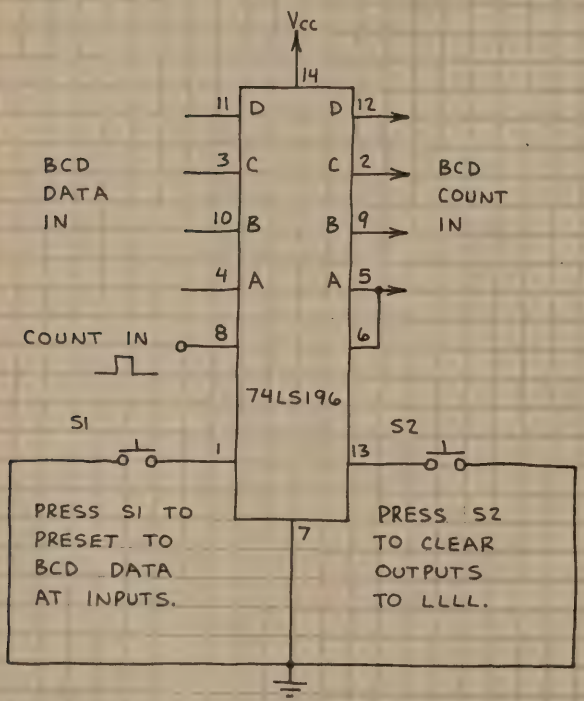


BCD (DECADE) COUNTER 74LS196

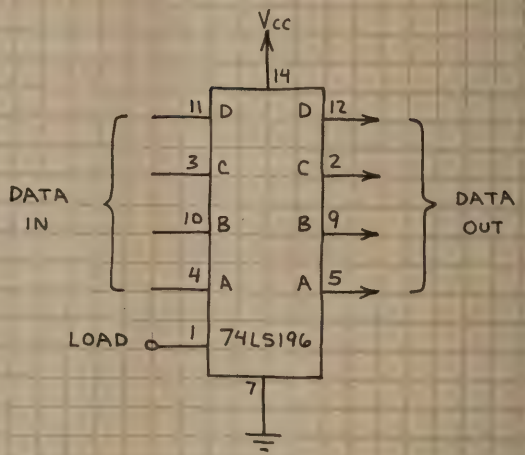
MORE SOPHISTICATED VERSION OF THE POPULAR 7490/74LS90 BCD COUNTER. INCLUDES 4-PRESET INPUTS WHICH PERMIT ANY BCD NUMBER TO BE LOADED WHEN PIN 1 IS MADE LOW. THE COUNTER IS CLEARED TO LLLL WHEN PIN 13 IS MADE LOW. ϕ INDICATES CLOCK INPUT.



DECADE COUNTER

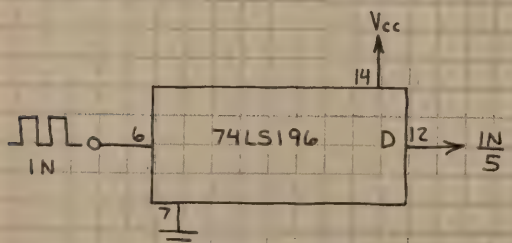


4-BIT LATCH



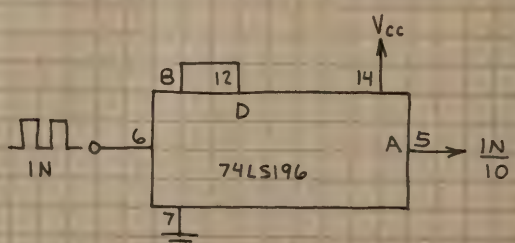
WHEN LOAD INPUT IS LOW, OUTPUTS FOLLOW INPUTS. NO CHANGE WHEN LOAD INPUT IS HIGH. NOTE THAT A PAIR OF 74LS196'S CAN BE USED IN A DECIMAL COUNTING UNIT (COUNTER PLUS REGISTER).

DIVIDE-BY-5 COUNTER



0-4 COUNT IS AVAILABLE AT DCBA OUTPUTS.

DIVIDE-BY-10 COUNTER



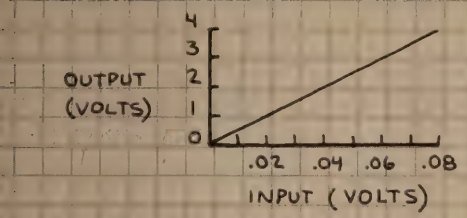
NOTES

NOTES

LINEAR INTEGRATED CIRCUITS

INTRODUCTION

THE OUTPUT OF A LINEAR IC IS PROPORTIONAL TO THE SIGNAL AT ITS INPUT. THE CLASSIC LINEAR IC IS THE OPERATIONAL AMPLIFIER. THIS GRAPH SHOWS THE LINEAR INPUT-OUTPUT RELATIONSHIP OF A TYPICAL OP-AMP CIRCUIT:



MANY NON-DIGITAL ICs — INCLUDING OP-AMPS — CAN BE USED IN BOTH LINEAR AND NON-LINEAR MODES. THEY ARE SOMETIMES DESCRIBED AS ANALOG ICs.

LINEAR ICs GENERALLY REQUIRE MORE EXTERNAL COMPONENTS THAN DIGITAL ICs. THIS INCREASES THEIR SUSCEPTABILITY TO EXTERNAL NOISE AND MAKES THEM A LITTLE TRICKIER TO USE. ON THE OTHER HAND, SOME LINEAR ICs CAN DO ESSENTIALLY THE SAME THING AS A NETWORK OF DIGITAL CHIPS.

HERE'S A BRIEF DESCRIPTION OF THE LINEAR CHIPS IN THIS SECTION:

VOLTAGE REGULATORS

PROVIDE A STEADY VOLTAGE, EITHER FIXED OR ADJUSTABLE, THAT IS UNAFFECTED BY CHANGES IN THE SUPPLY VOLTAGE AS LONG AS THE SUPPLY VOLTAGE IS ABOVE THE DESIRED OUTPUT VOLTAGE.

OPERATIONAL AMPLIFIERS

THE IDEAL AMPLIFIER . . . ALMOST. HIGH INPUT IMPEDANCE AND GAIN. LOW OUTPUT IMPEDANCE. GAIN IS EASILY CONTROLLED WITH A SINGLE FEEDBACK RESISTOR. FET INPUT OP-AMPS (BIFETS) HAVE A VERY HIGH FREQUENCY RESPONSE. IT'S USUALLY OK TO SUBSTITUTE OP-AMPS IF BOTH ARE NORMALLY POWERED BY A DUAL POLARITY SUPPLY (½ LF353 FOR 741C, ETC.)... BUT PERFORMANCE WILL IMPROVE OR DECREASE ACCORDING TO THE NEW OP-AMP'S SPECIFICATIONS.

COMPARATOR

SAME AS AN OP-AMP WITHOUT A FEEDBACK RESISTOR. ULTRA-HIGH GAIN GIVES A SNAP-LIKE RESPONSE TO AN INPUT VOLTAGE AT ONE INPUT THAT EXCEEDS A REFERENCE VOLTAGE AT THE SECOND INPUT.

TIMERS

USE ALONE OR WITH OTHER ICs FOR NUMEROUS TIMING AND PULSE GENERATION APPLICATIONS.

LED CHIPS

MOST IMPORTANT ARE A FLASHER CHIP AND A DOT-BARGRAPH ANALOG-TO-DIGITAL DISPLAY. VERY EASY TO USE.

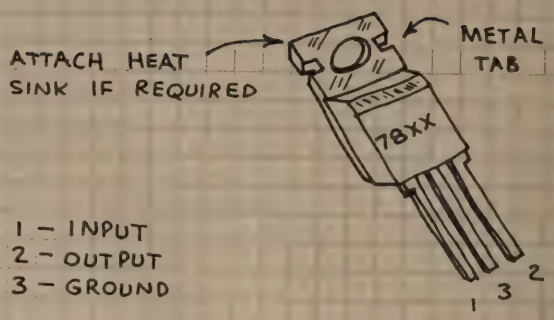
OSCILLATORS

A VOLTAGE CONTROLLED OSCILLATOR AND A COMBINED VOLTAGE-TO-FREQUENCY AND FREQUENCY-TO-VOLTAGE CONVERTER. ALSO INCLUDED IS A TONE DECODER THAT CAN BE SET TO INDICATE A SPECIFIC FREQUENCY.

AUDIO AMPLIFIERS

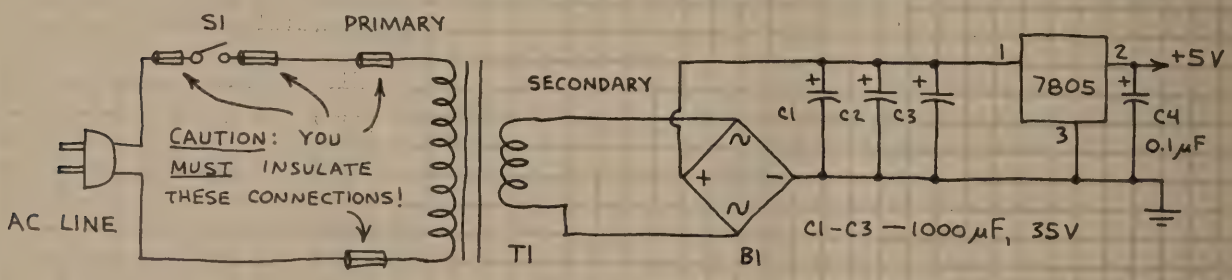
THIS SECTION INCLUDES SEVERAL EASY TO USE POWER AMPLIFIERS THAT ARE IDEAL FOR DO-IT-YOURSELF STEREO, PUBLIC ADDRESS SYSTEMS, INTERCOMS AND OTHER AUDIO APPLICATIONS.

VOLTAGE REGULATORS
7805 (5-VOLTS)
7812 (12-VOLTS)
7815 (15-VOLTS)



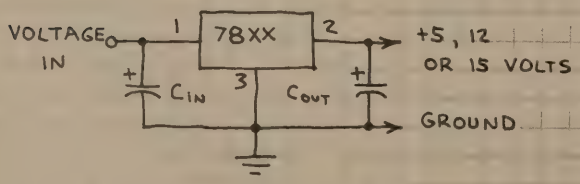
FIXED VOLTAGE REGULATORS. IDEAL FOR STAND-ALONE POWER SUPPLIES, ON-CARD REGULATORS, AUTOMOBILE BATTERY POWERED PROJECTS, ETC. UP TO 1.5 AMPERES OUTPUT IF PROPERLY HEAT SUNK AND SUFFICIENT INPUT CURRENT AVAILABLE. THERMAL SHUTDOWN CIRCUIT TURNS OFF REGULATOR IF HEATSINK TOO SMALL.

5-VOLT LINE POWERED TTL/LS POWER SUPPLY



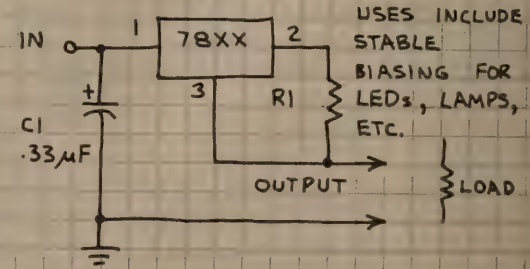
T1 — 117-12.6 V, 1.2 A OR 3A TRANSFORMER (273-1505 OR 273-1511).
B1 — 1A-4A FULL WAVE BRIDGE RECTIFIER (276-1161, 276-1151 OR 276-1171).
(RADIO SHACK CATALOG NUMBERS IN PARENTHESES.)

VOLTAGE REGULATOR



CIN — OPTIONAL; USE 0.33μF OR SO IF REGULATOR FAR FROM POWER SUPPLY.
COUT — OPTIONAL; USE 0.1μF OR MORE TO TRAP SPIKES THAT BOTHER LOGIC ICs.

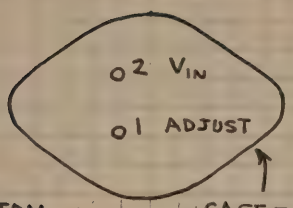
CURRENT REGULATOR



OUTPUT CURRENT = $\frac{\text{REGULATOR VOLTS}}{R1}$

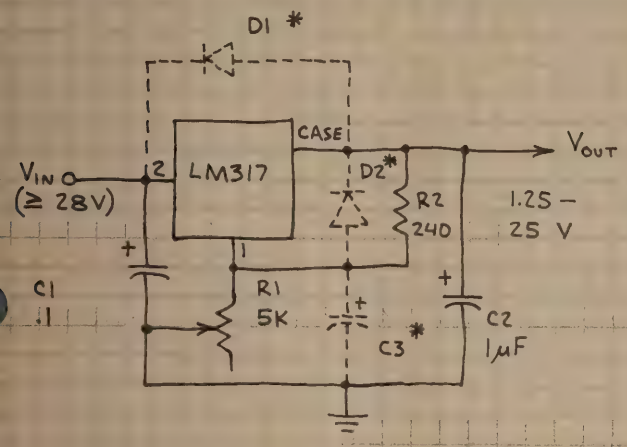
1.2-37 VOLT REGULATOR
LM317

CAN SUPPLY UP TO 1.5 AMPERES OVER A 1.2-37 VOLT OUTPUT RANGE. NOTE MINIMUM NUMBER OF EXTERNAL COMPONENTS IN BASIC REGULATOR CIRCUIT BELOW. USE HEAT SINK FOR APPLICATIONS REQUIRING FULL POWER OUTPUT. SEE APPROPRIATE DATA BOOK FOR ADDITIONAL INFORMATION:



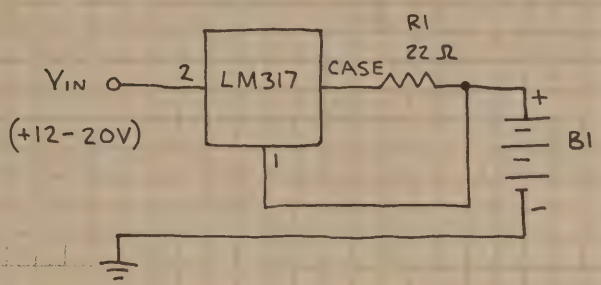
BOTTOM VIEW (TO-3 CASE)

1.25-25 VOLT REGULATOR



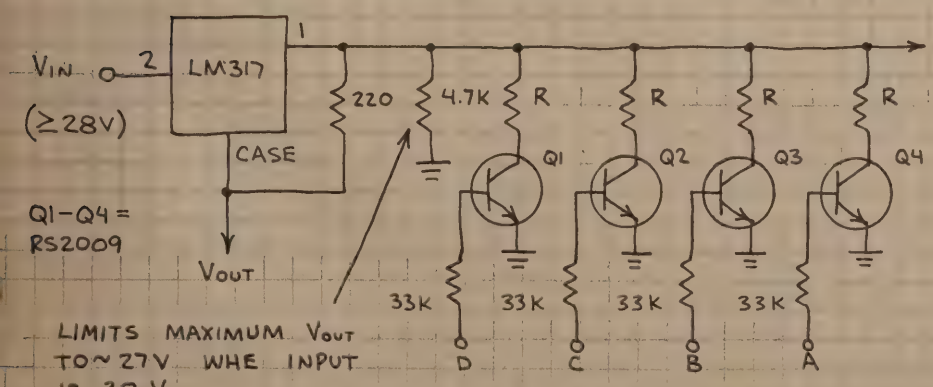
VIN SHOULD BE FILTERED. OK TO OMIT C1 IF VIN VERY CLOSE TO LM317.
R1 CONTROLS OUTPUT VOLTAGE.
* ADD IF OUTPUT > 25 V AND C2 > 25μF.

6-VOLT NICAD CHARGER



B1 IS BATTERY OF 4 NICKEL CADMIUM STORAGE CELLS IN SERIES. THIS CIRCUIT CHARGES B1 AT A CURRENT OF 51.2 mA. INCREASE R1 TO REDUCE CURRENT. FOR EXAMPLE, CURRENT IS 43 mA WHEN R1 IS 24 OHMS.

PROGRAMMABLE POWER SUPPLY



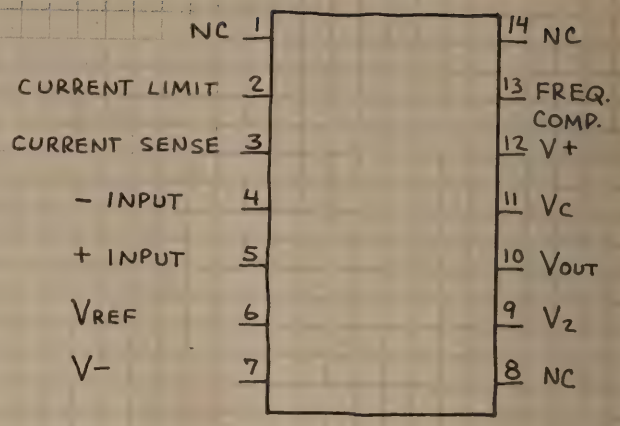
DCBA INPUTS: CONNECT TO PIN 2 TO SELECT.

R	VOUT
100	1.8
330	3.0
470	4.0
1K	7.3
2.2K	13.5
3.3K	18.0

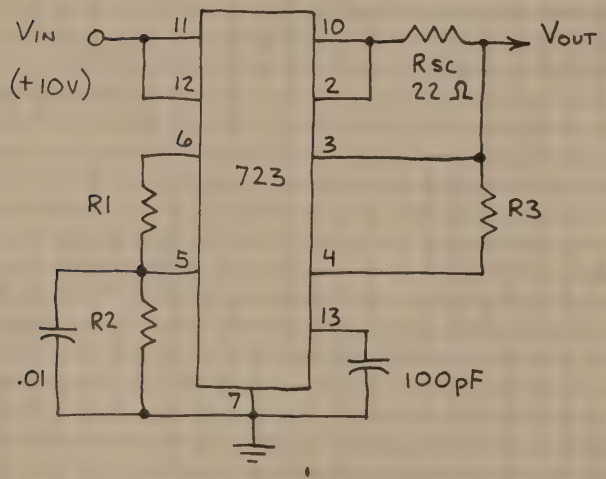
2-37 VOLT REGULATOR

723

VERY VERSATILE SERIES REGULATOR. UP TO 40 VOLTS INPUT AND 2-37 VOLT OUTPUT. MAXIMUM OUTPUT CURRENT OF 150 mA CAN BE EXTENDED TO 10 A BY ADDING EXTERNAL POWER TRANSISTORS. SHOWN BELOW ARE TWO BASIC CIRCUITS. TRY THESE, THEN SEE APPROPRIATE DATA BOOK FOR ADDITIONAL CIRCUITS.



2-7 VOLT REGULATOR



TYPICAL VALUES

VOUT	R1	R2	R3
3.0	4.12 K	3.01 K	1.74K
3.6	3.57 K	3.65 K	1.80K
5.0	2.15 K	4.99 K	1.50K
6.0	1.15 K	6.04K	966

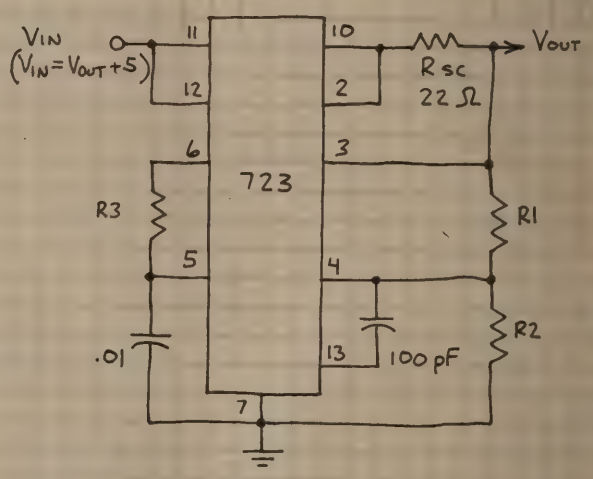
FOR ANY VOLTAGE BETWEEN 2-7 VOLTS:

$$V_{OUT} = (V_{REF}^{*}) \times \left(\frac{R2}{R + R2}\right)$$

*V_{REF} = 6.8 - 7.5 V (MEASURE AT PIN 6)

$$R3 = \frac{R1 \times R2}{R1 + R2}$$

7-37 VOLT REGULATOR



TYPICAL VALUES

VOUT	R1	R2	R3
9	1.87 K	7.15 K	.48K
12	4.87 K	7.15 K	2.90K
15	7.87 K	7.15 K	3.75 K
28	21.0 K	7.15 K	5.33K

FOR ANY VOLTAGE BETWEEN 7-37 VOLTS:

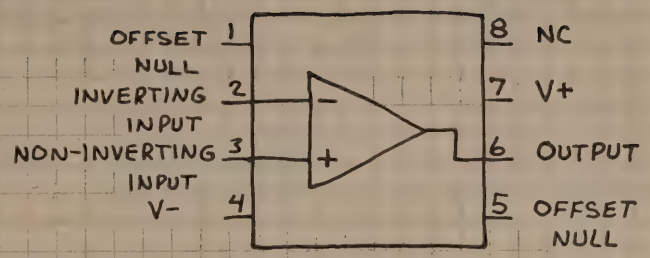
$$V_{OUT} = (V_{REF}^{*}) \times \left(\frac{R1 + R2}{R2}\right)$$

$$R3 = \frac{R1 \times R2}{R1 + R2}$$ (R3, WHICH IS OPTIONAL, GIVES TEMPERATURE STABILITY)

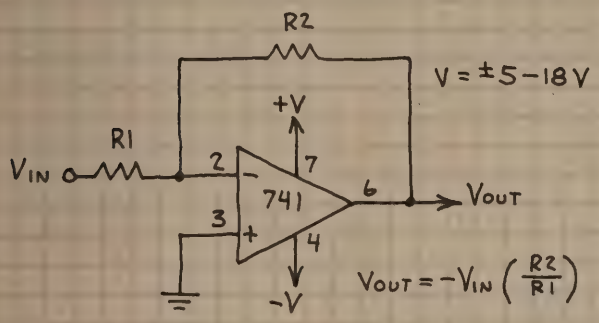
OPERATIONAL AMPLIFIER

741C

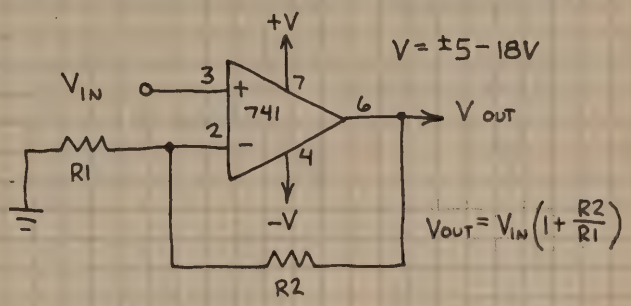
THE MOST POPULAR OP-AMP. USE FOR ALL GENERAL PURPOSE APPLICATIONS. (FOR SINGLE SUPPLY OPERATION AND VERY HIGH INPUT IMPEDANCE, USE OTHER OP-AMPS IN THIS NOTEBOOK.)



INVERTING AMPLIFIER

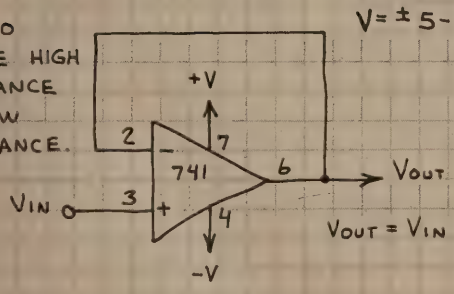


NON-INVERTING AMPLIFIER

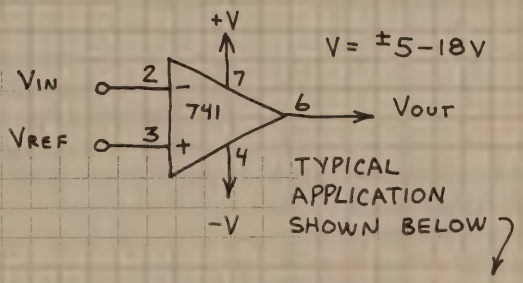


UNITY GAIN FOLLOWER

USE TO COUPLE HIGH IMPEDANCE TO LOW IMPEDANCE.

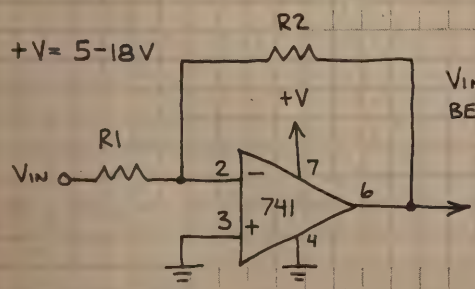


COMPARATOR



TYPICAL APPLICATION SHOWN BELOW

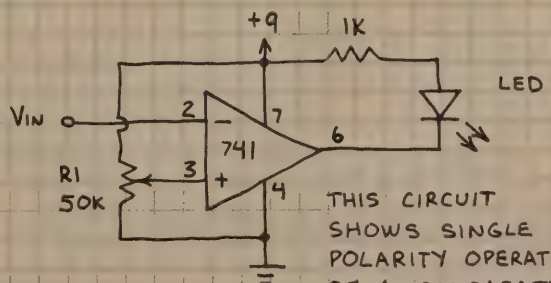
SINGLE POLARITY SUPPLY



VIN MUST BE NEGATIVE.

TYPICAL USES: AMPLIFICATION OF DC VOLTAGE AND PULSES.

LEVEL DETECTOR

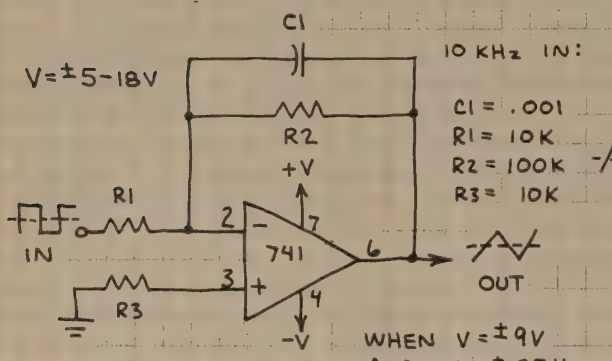


THIS CIRCUIT SHOWS SINGLE POLARITY OPERATION OF A COMPARATOR.

RI SETS THE VOLTAGE DETECTION THRESHOLD (UP TO +9). WHEN VIN EXCEEDS THE THRESHOLD (ALSO CALLED THE REFERENCE), THE LED GLOWS.

741C

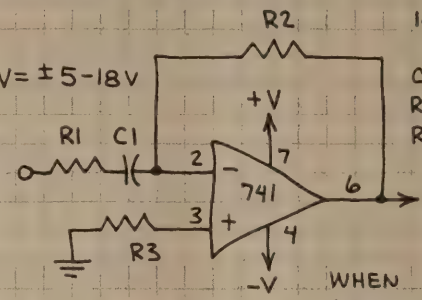
BASIC INTEGRATOR



10 KHz IN:
C1 = .001
R1 = 10K
R2 = 100K
R3 = 10K

WHEN V = ±9V
AND IN = ±.25V,
OUT = ± 1V.

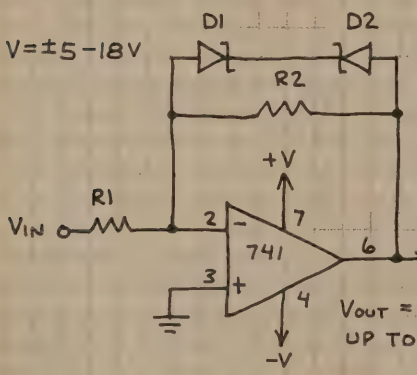
BASIC DIFFERENTIATOR



10 KHz IN:
C1 = .00022μF
R1 = 100K
R2, R3 = 10K

WHEN V = ±9V
AND IN = ±.25V,
OUT = ±.25V

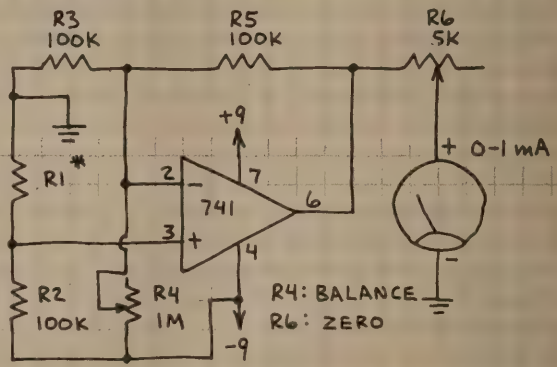
CLIPPING AMPLIFIER



D1 AND D2 = ZENER DIODES. IF $V_Z = 6V$, THEN OUTPUT CANNOT EXCEED ±6.7 V.

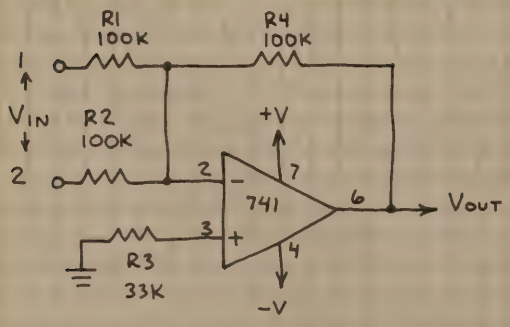
$V_{OUT} = -V_{IN}\left(\frac{R2}{R1}\right)$ ... UP TO $V_Z + 0.7$ V.

BRIDGE AMPLIFIER



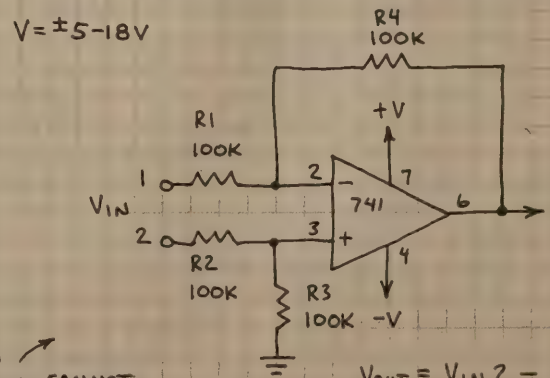
*R1 IS UNKNOWN RESISTOR. USE CdS CELL FOR R1 TO MAKE A VERY SENSITIVE LIGHT METER.

SUMMING AMPLIFIER



$V_{OUT} = -(V_{IN}1 + V_{IN}2)$

DIFFERENCE AMPLIFIER

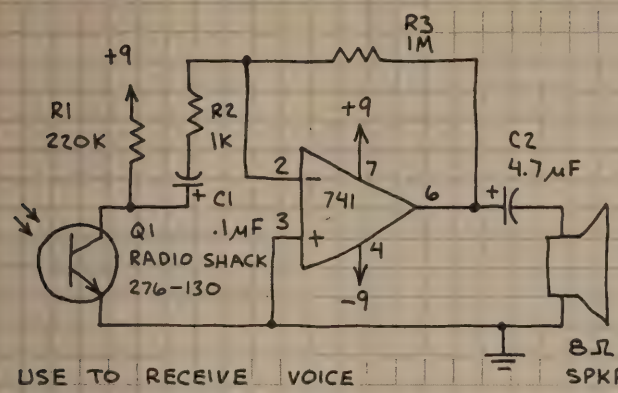


NOTE: V_{OUT} CANNOT EXCEED ±V.

$V_{OUT} = V_{IN}2 - V_{IN}1$

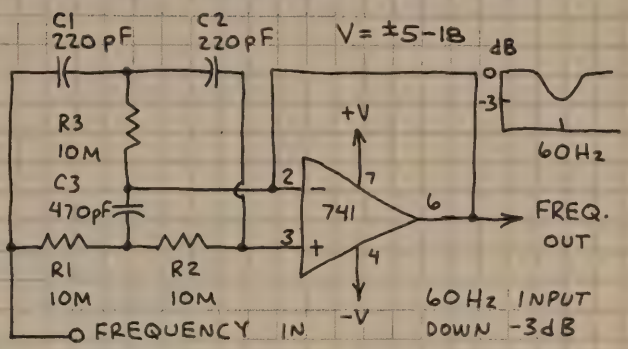
OPERATIONAL AMPLIFIER (CONTINUED)
741C

LIGHT WAVE RECEIVER

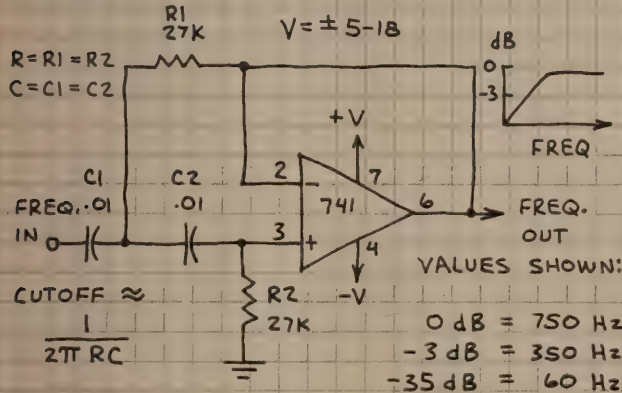


USE TO RECEIVE VOICE MODULATED LIGHT WAVES. OK TO USE SINGLE POLARITY POWER SUPPLY FOR NON-VOICE RECEPTION.

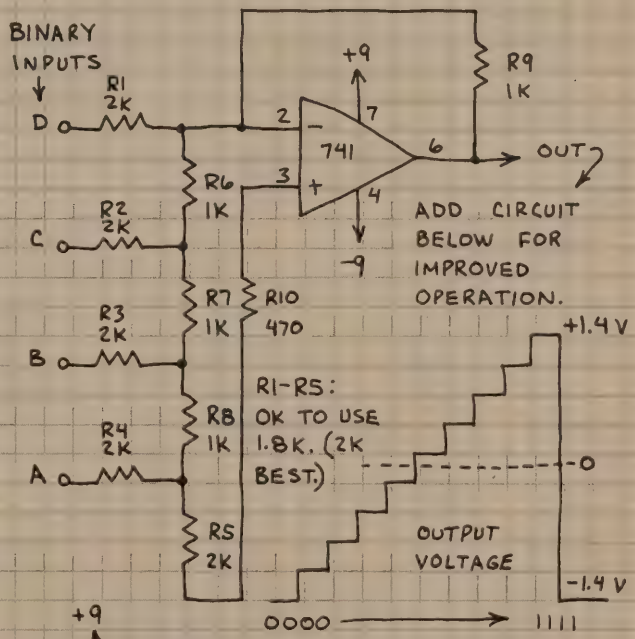
60-Hz NOTCH FILTER



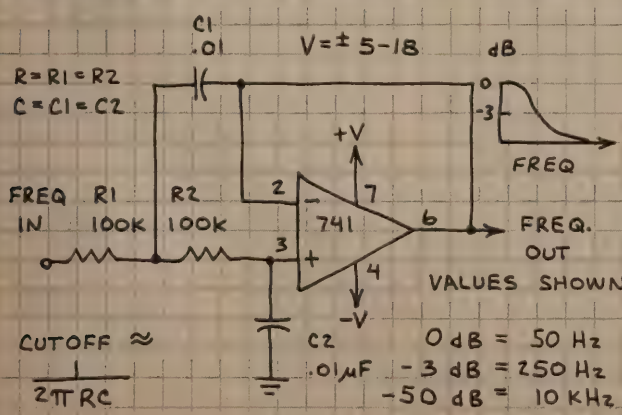
HIGH PASS ACTIVE FILTER

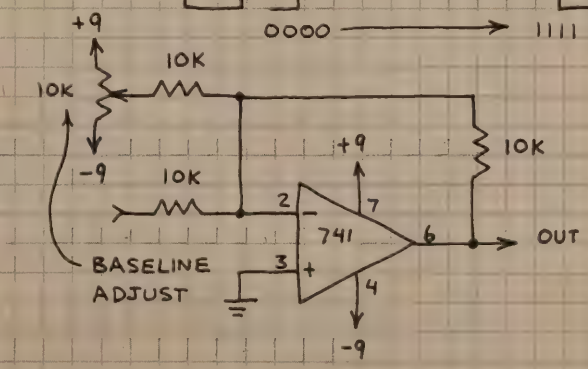


4-BIT D/A CONVERTER



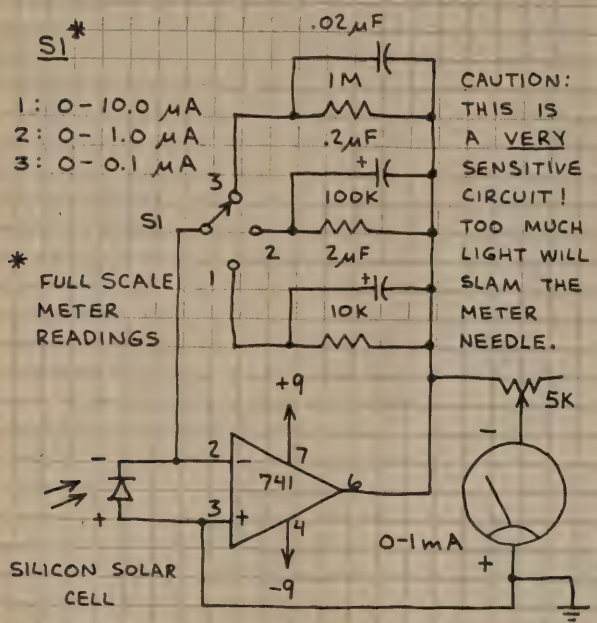
LOW PASS ACTIVE FILTER





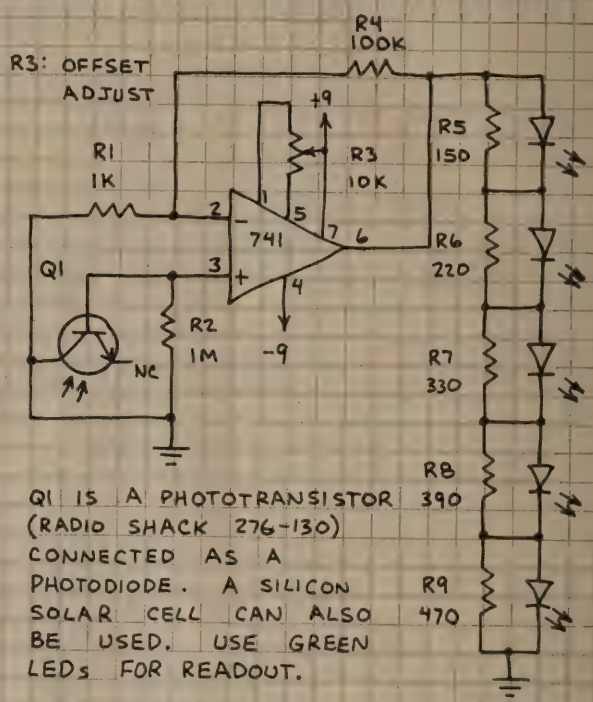
OPERATIONAL AMPLIFIER (CONTINUED)
741C

OPTICAL POWER METER



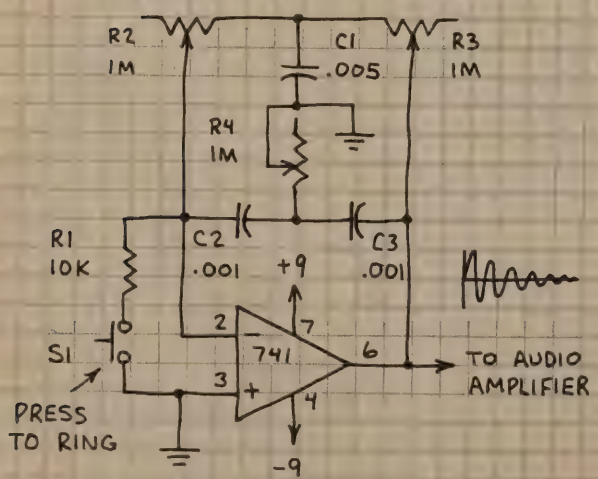
THIS CIRCUIT CAN BE USED AS A FAIRLY GOOD QUALITY RADIOMETER.

BARGRAPH LIGHT METER



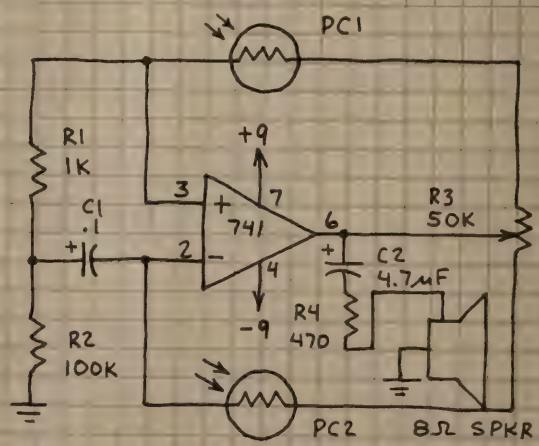
Q1 IS A PHOTOTRANSISTOR (RADIO SHACK 276-130) CONNECTED AS A PHOTODIODE. A SILICON SOLAR CELL CAN ALSO BE USED. USE GREEN LEDs FOR READOUT.

ELECTRONIC BELL



ADJUST R3 TO JUST BELOW OSCILLATION POINT. ADJUST R2 AND R3 FOR SOUNDS SUCH AS BELL, DRUM, TINKLING, ETC.

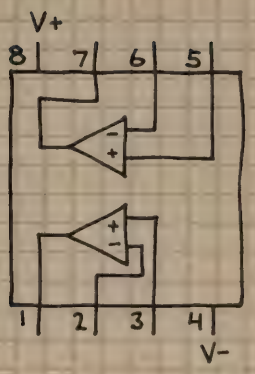
AUDIBLE LIGHT SENSOR



PC1, PC2 — CdS PHOTOCELLS (RADIO SHACK 276-116)

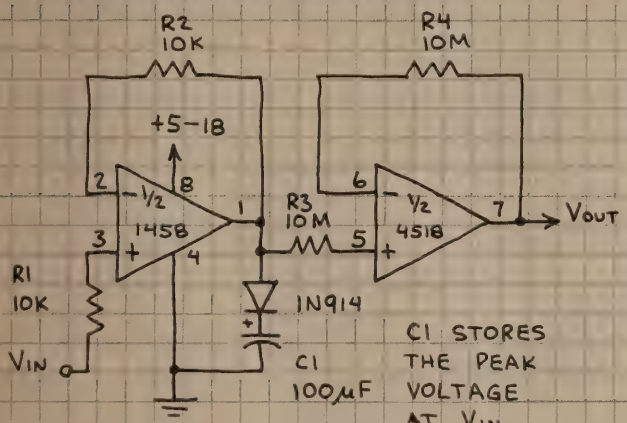
LIGHT ON PC1 DECREASES TONE FREQUENCY.
LIGHT ON PC2 INCREASES TONE FREQUENCY.

DUAL OPERATIONAL AMPLIFIER
1458



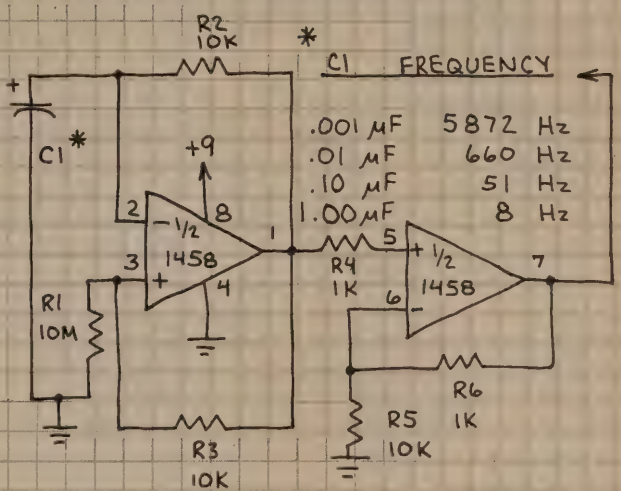
TWO 741C OP-AMPS IN A SINGLE 8-PIN MINI-DIP. TRY TO USE THIS CHIP FOR CIRCUITS THAT REQUIRE TWO OR MORE 741'S. YOU'LL SAVE TIME, SPACE AND MONEY.

PEAK DETECTOR



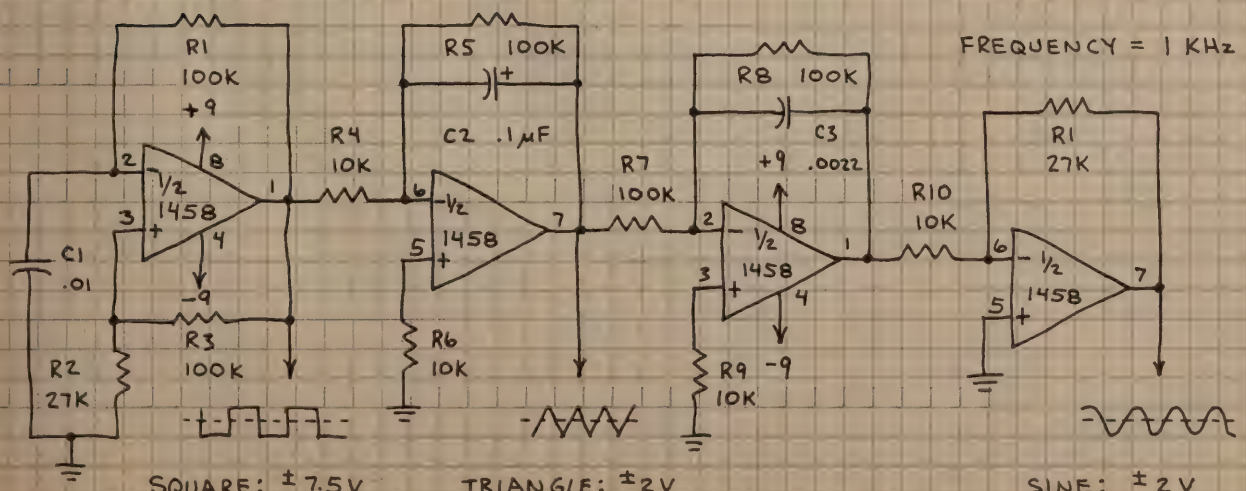
APPLICATIONS INCLUDE USE AS ANALOG "MEMORY" THAT STORES PEAK AMPLITUDE OF A FLUCTUATING VOLTAGE.

PULSE GENERATOR



PULSES ARE DC. AMPLITUDE WHEN C1 = 0.1μF IS 5 VOLTS.

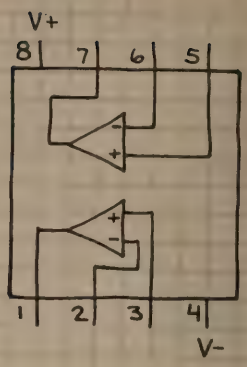
FUNCTION GENERATOR



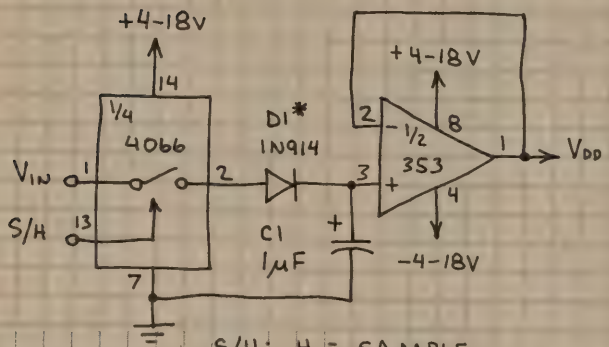
SQUARE: ±7.5V TRIANGLE: ±2V SINE: ±2V

DUAL OPERATIONAL AMPLIFIER LF353N (JFET INPUT)

HIGH IMPEDANCE (10^{12} OHM) JUNCTION FET INPUTS. OUTPUT SHORT CIRCUIT PROTECTION. HIGH SLEW RATE (13V/μSEC), LOW NOISE OPERATION. AMPLIFIERS ARE SIMILAR TO THOSE IN THE TL084C. NOTE THAT PIN CONNECTIONS ARE THE SAME AS 1458. THIS OP-AMP, HOWEVER, OFFERS MUCH BETTER PERFORMANCE.



SAMPLE AND HOLD

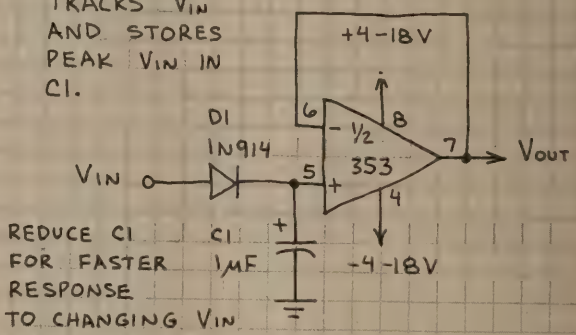


S/H: H = SAMPLE
L = HOLD

*OPTIONAL

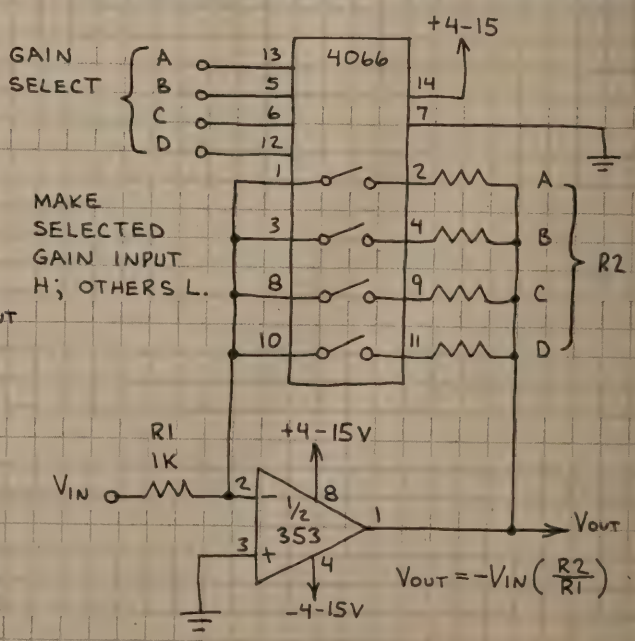
PEAK DETECTOR

TRACKS V_{IN} AND STORES PEAK V_{IN} IN C1.

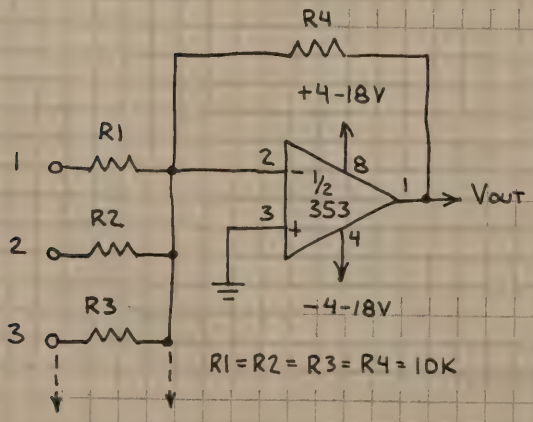


REDUCE C1 FOR FASTER RESPONSE TO CHANGING V_{IN}

PROGRAMMABLE GAIN OP-AMP



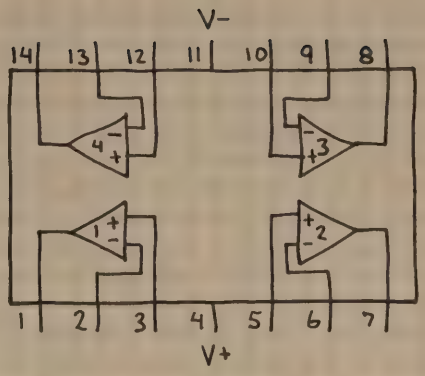
AUDIO MIXER



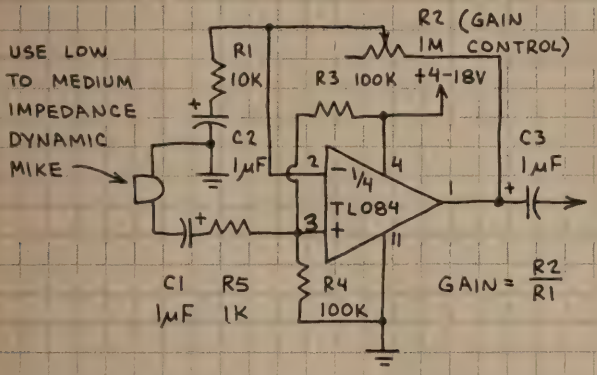
CONNECT OUTPUTS OF PREAMPLIFIERS TO INPUTS 1-3. OK TO ADD MORE CHANNELS. WORKS WELL WITH TL084 MICROPHONE PREAMPLIFIERS.

QUAD OPERATIONAL AMPLIFIER
TL084C (JFET INPUT)

HIGH IMPEDANCE (10^{12} OHMS) JUNCTION FET INPUTS. OUTPUT SHORT CIRCUIT PROTECTION. HIGH SLEW RATE (12 V/μSEC) PLUS LOW NOISE OPERATION. PERFORMANCE SIMILAR TO LF353N. NOTE THAT PIN CONNECTIONS ARE SAME AS LM324.

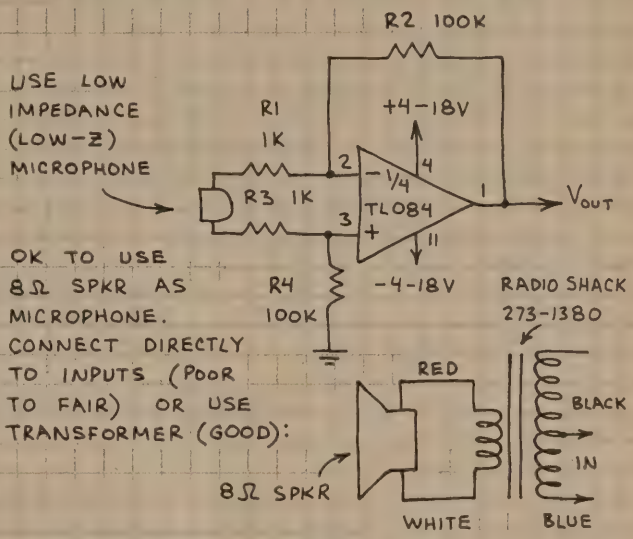


MICROPHONE PREAMPLIFIER

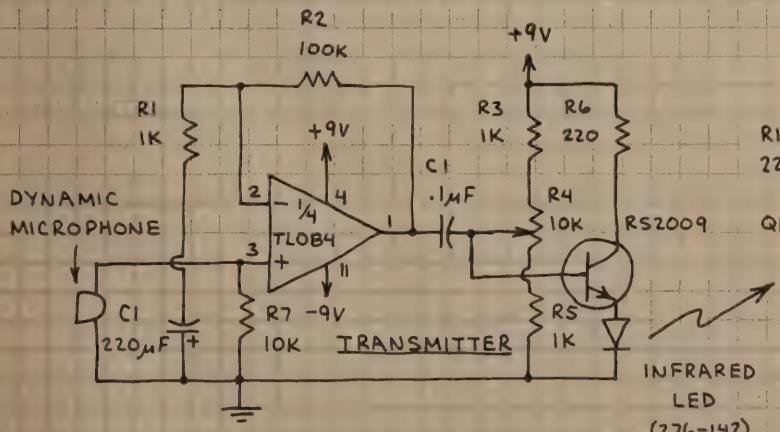


NOTE SINGLE POLARITY POWER SUPPLY (THANKS TO R3 AND R4) AND AC COUPLING.

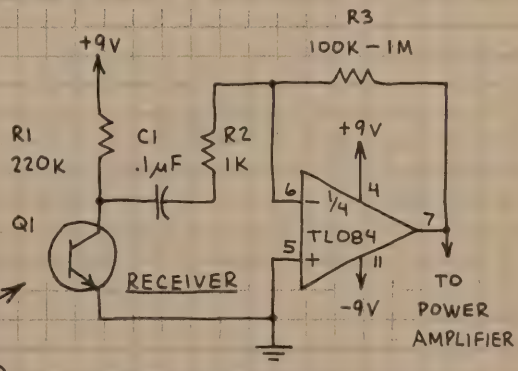
LOW-Z PREAMPLIFIER



INFRARED VOICE COMMUNICATOR



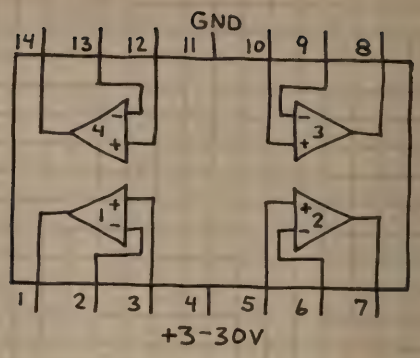
POINT THE LED AT Q1 AND ADJUST R4 UNTIL BEST VOICE QUALITY IS OBTAINED. (R4 APPLIES PREBIAS TO LED.) R6 LIMITS MAXIMUM LED CURRENT TO A SAFE 40 mA.



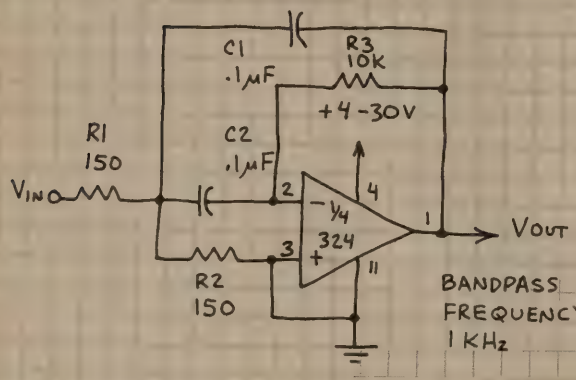
USE RADIO SHACK 276-130 PHOTOTRANSISTOR FOR Q1. MAXIMUM RANGE: HUNDREDS OF FEET AT NIGHT WITH LENSES AT Q1 AND LED. POWER AMP: SEE LM386.

QUAD OPERATIONAL AMPLIFIER LM324N

OPERATES FROM SINGLE POLARITY POWER SUPPLY. MORE GAIN (100 dB) BUT LESS BANDWIDTH (1 MHz WHEN GAIN IS 1) THAN THE LM3900 QUAD OP-AMP. NOTE UNUSUAL LOCATION OF POWER SUPPLY PINS. CAUTION: SHORTING THE OUTPUTS DIRECTLY TO V+ OR GND OR REVERSING THE POWER SUPPLY MAY DAMAGE THIS CHIP.

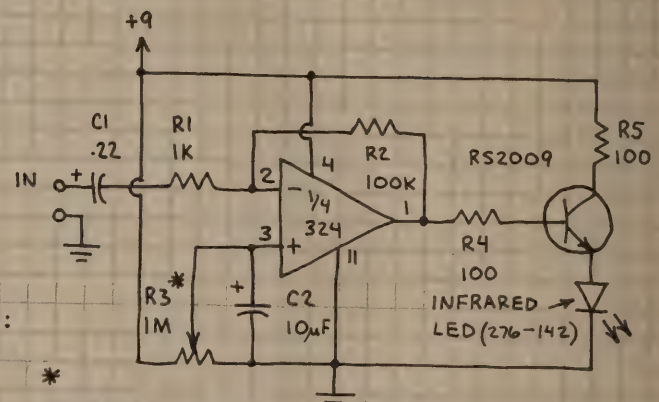


BANDPASS FILTER



BANDPASS FREQUENCY: 1 KHz

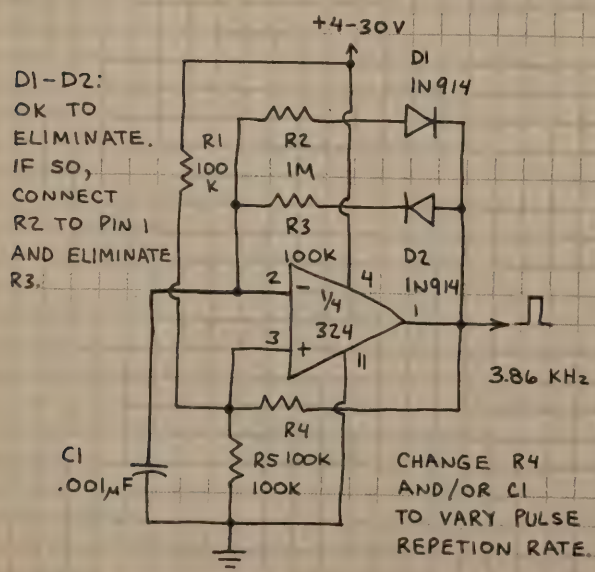
INFRARED TRANSMITTER



* CAREFULLY ADJUST R3 FOR BEST VOICE QUALITY. FOR MORE POWER REDUCE R5 TO 50Ω... BUT DO NOT ALLOW MORE THAN 30 mA THROUGH LED!

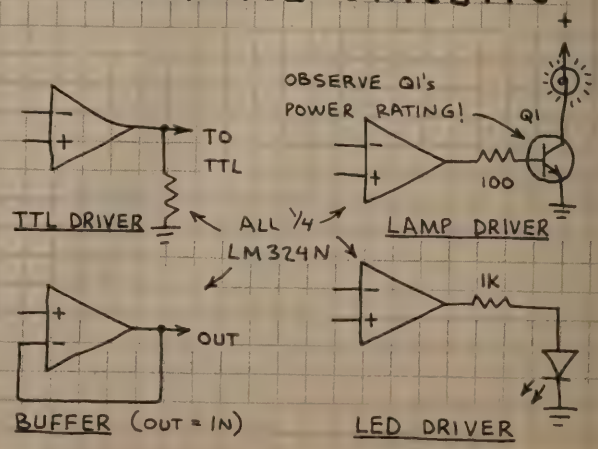
USE DYNAMIC MICROPHONE AT INPUT. RECEIVE SIGNAL WITH PHOTOTRANSISTOR PLUS OP-AMP.

PULSE GENERATOR



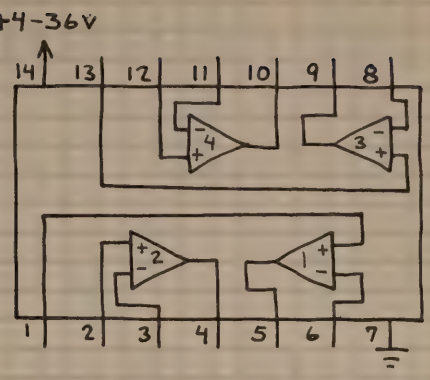
CHANGE R4 AND/OR C1 TO VARY PULSE REPETION RATE.

INTERFACE CIRCUITS



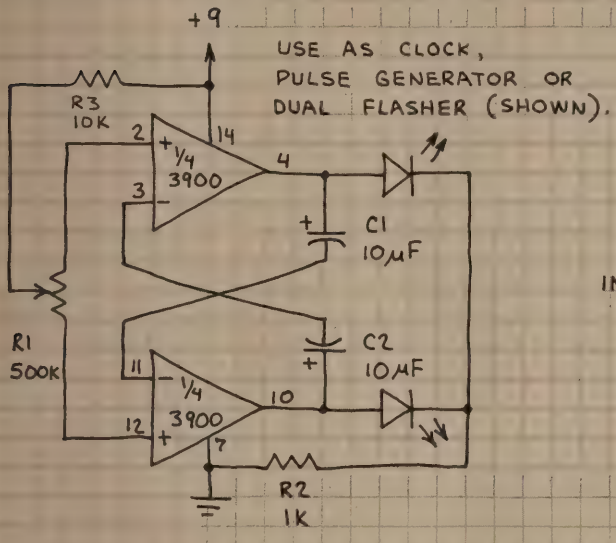
QUAD OPERATIONAL AMPLIFIER LM3900N

OPERATES FROM SINGLE POLARITY POWER SUPPLY. LESS GAIN (70 dB) BUT WIDER BANDWIDTH (25 MHz AT GAIN OF 1) THAN THE LM324 QUAD OP-AMP. NOTE STANDARD POWER SUPPLY PIN LOCATIONS. CAUTION: SHORTING THE OUTPUTS DIRECTLY TO V+ OR GROUND OR REVERSED POWER CONNECTIONS MAY DAMAGE THIS CHIP.

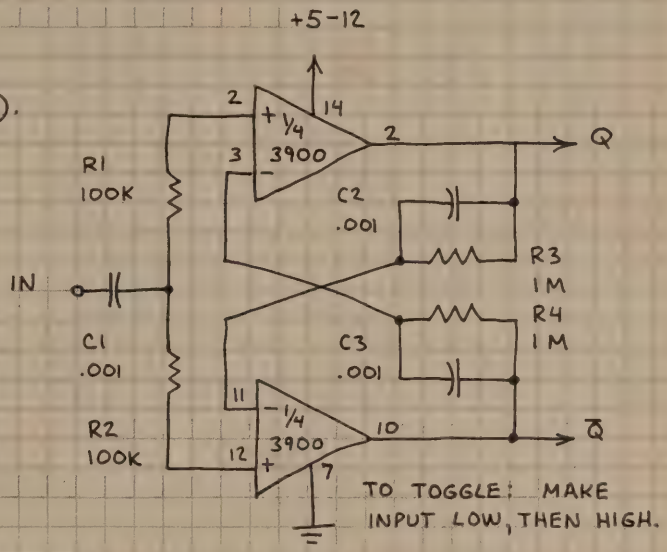


NOTE: DO NOT SUBSTITUTE LM3900 FOR OTHER OP-AMPS

ASTABLE MULTIVIBRATOR

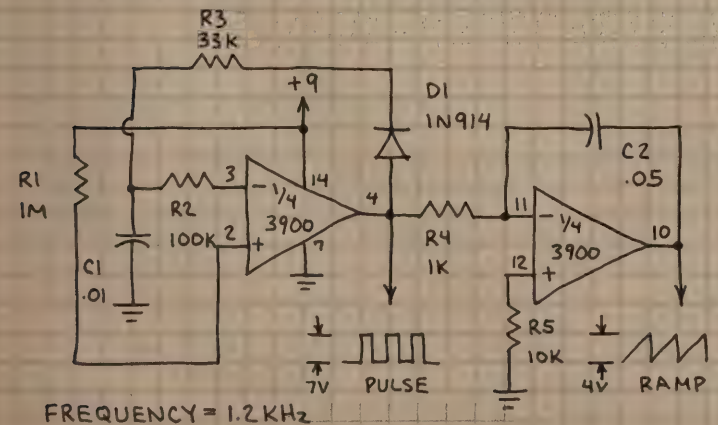


TOGGLE FLIP-FLOP



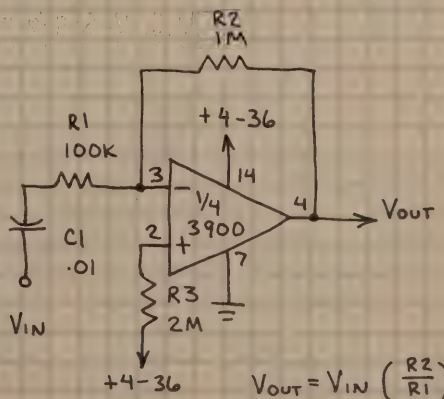
TO TOGGLE: MAKE INPUT LOW, THEN HIGH.

FUNCTION GENERATOR



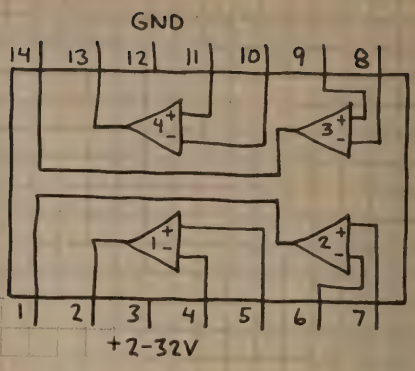
FREQUENCY = 1.2 KHz

X10 AMPLIFIER



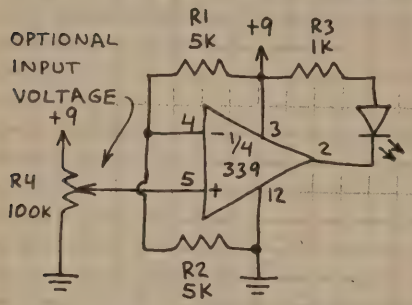
$V_{OUT} = V_{IN} \left(\frac{R2}{R1} \right)$

QUAD COMPARATOR
LM339 (276-1712)



FOUR INDEPENDENT VOLTAGE COMPARATORS IN A SINGLE PACKAGE. NOTE THAT A SINGLE POLARITY POWER SUPPLY IS REQUIRED. (MOST COMPARATORS ARE DESIGNED PRIMARILY FOR DUAL SUPPLY OPERATION.) NOTE UNUSUAL LOCATION OF THE SUPPLY PINS. COMPARATORS MAY OSCILLATE IF OUTPUT LEAD IS TOO CLOSE TO INPUT LEADS. GROUND ALL PINS OF UNUSED COMPARATORS.

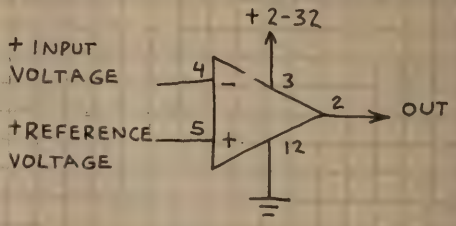
NON-INVERTING COMPARATOR



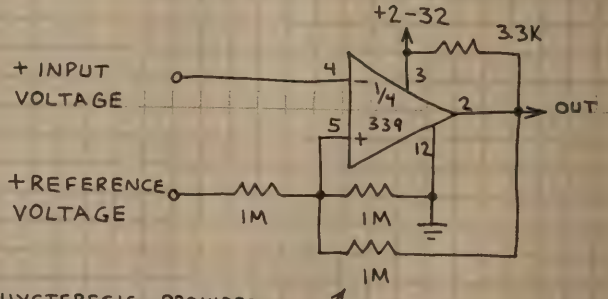
R1-R2 DETERMINE REFERENCE VOLTAGE (4.5 V AS SHOWN).

LED GLOWS WHEN INPUT VOLTAGE (PIN 5) FALLS BELOW REFERENCE VOLTAGE (PIN 4).

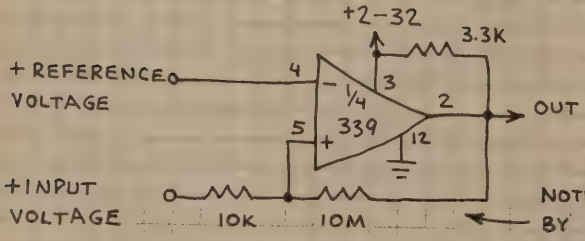
INVERTING COMPARATOR



INVERTING COMPARATOR WITH HYSTERESIS

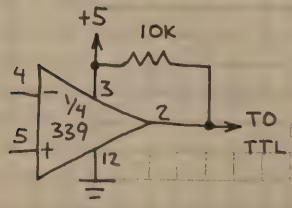


NON-INVERTING COMPARATOR WITH HYSTERESIS

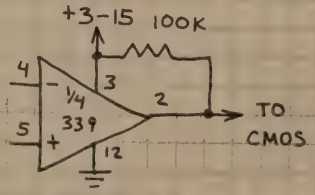


NOTE: HYSTERESIS PROVIDED BY FEEDBACK RESISTOR STOPS OSCILLATION.

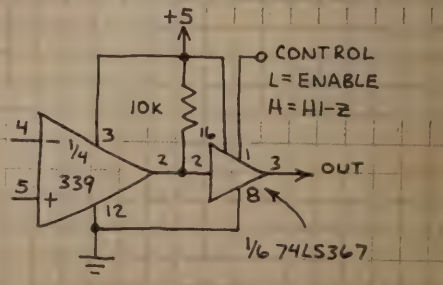
TTL DRIVER



CMOS DRIVER

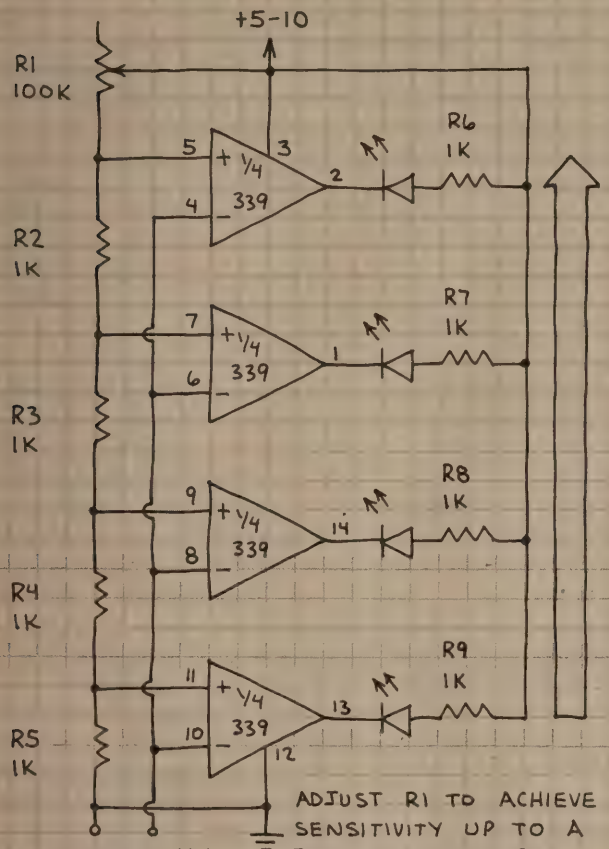


3-STATE OUTPUT



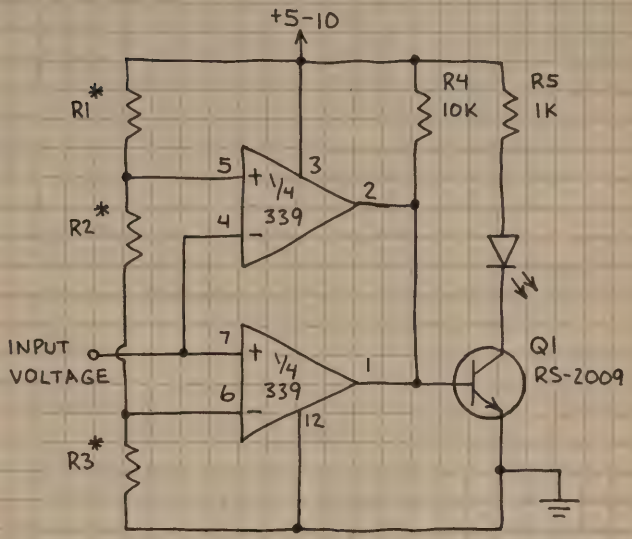
QUAD COMPARATOR (CONTINUED)
LM339

LED BARGRAPH READOUT



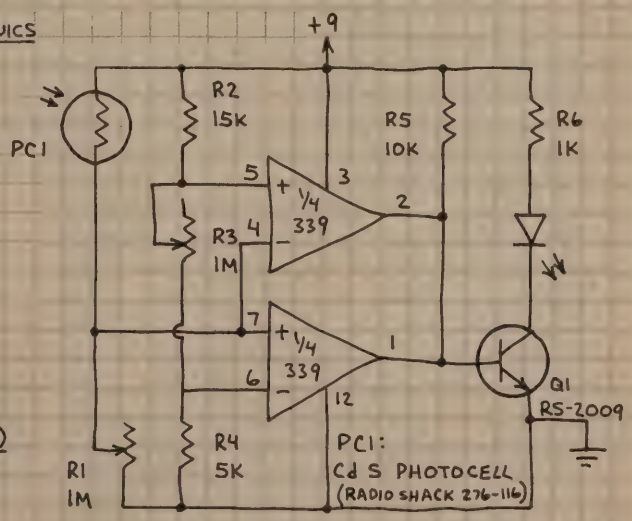
ADJUST R1 TO ACHIEVE SENSITIVITY UP TO A FEW MILLIVOLTS PER LED. SEE POPULAR ELECTRONICS (SEPT. 1978, PP. 92-97).

WINDOW COMPARATOR



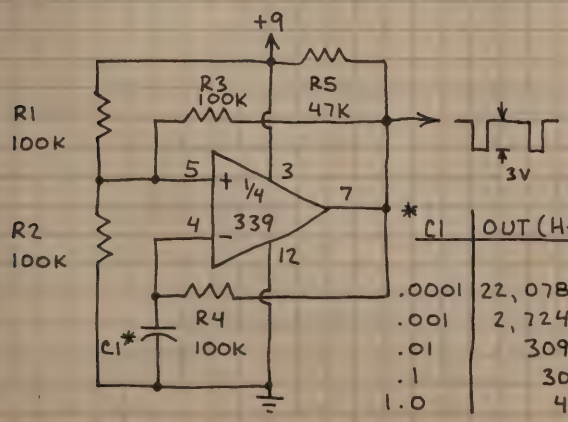
THE LED GLOWS WHEN THE INPUT VOLTAGE IS WITHIN THE WINDOW DETERMINED BY R1-R3. THE WINDOW IS 4-8 MILLIVOLTS WIDE WHEN R1 = 500Ω, R2 = 1200Ω AND R3 = 1M. IT EXTENDS FROM 1.5 - 4.2 VOLTS WHEN R1 AND R3 = 15,000Ω AND R2 = 25,000Ω. USE POTS FOR R1-R3 FOR A FULLY ADJUSTABLE WINDOW.

PROGRAMMABLE LIGHT METER



ADJUST R1 AND R3 SO LED GLOWS WHEN LIGHT AT PC1 IS ABOVE OR BELOW ANY DESIRED LEVEL.

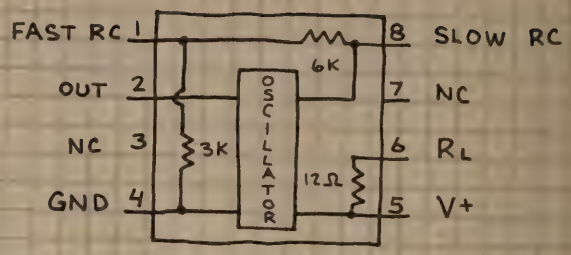
SQUAREWAVE OSCILLATOR



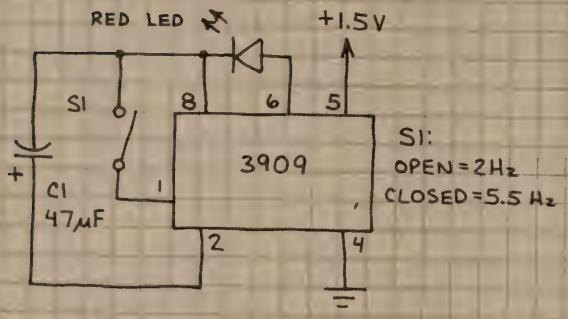
*C1	OUT (Hz)
.0001	22,078
.001	2,724
.01	309
.1	30
1.0	4

LED FLASHER / OSCILLATOR 3909

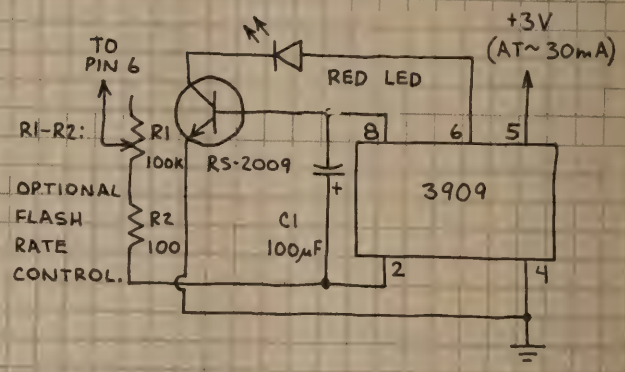
EASIEST TO USE IC IN THIS NOTEBOOK. FLASHES LEDs OR CAN BE USED AS TONE SOURCE. WILL DRIVE SPEAKER DIRECTLY. WILL FLASH A RED LED WHEN V+ IS ONLY 1.3 VOLTS.



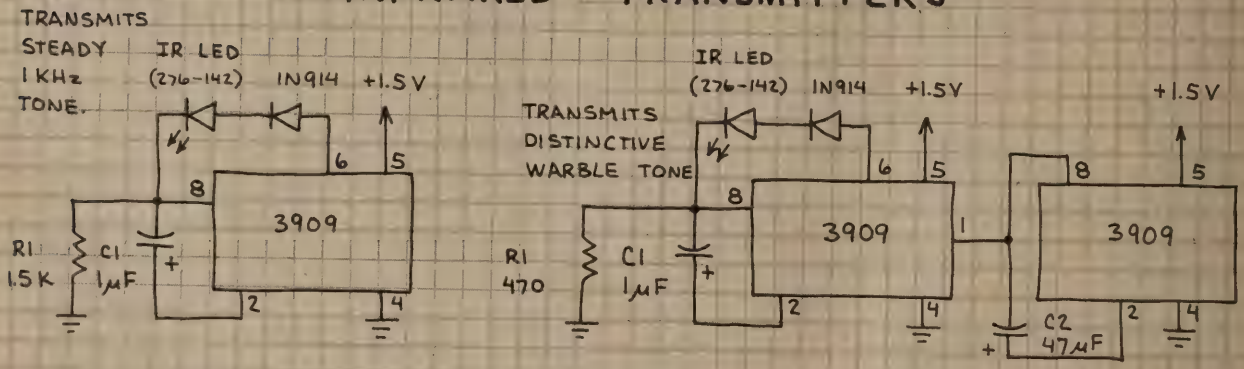
LED FLASHER



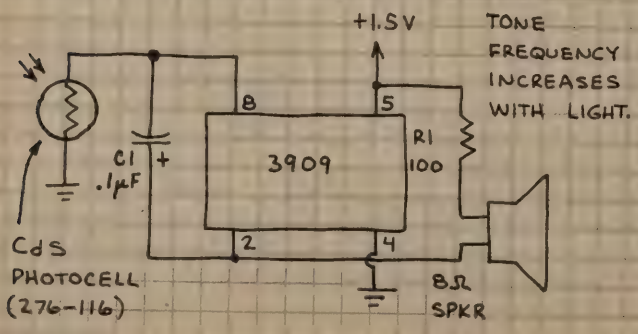
POWER FLASHER



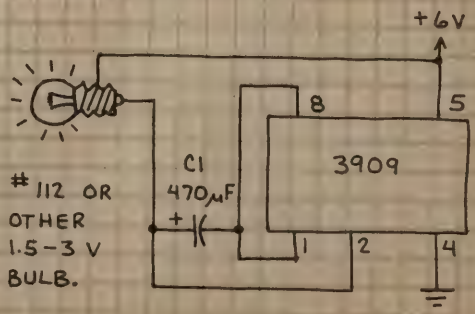
INFRARED TRANSMITTERS



LIGHT CONTROLLED TONE

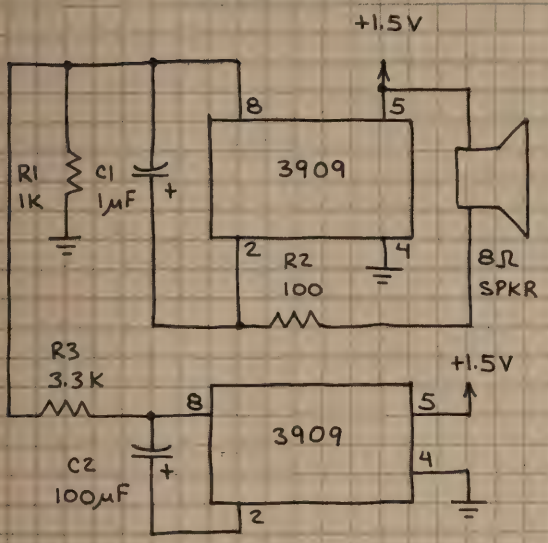


LAMP FLASHER

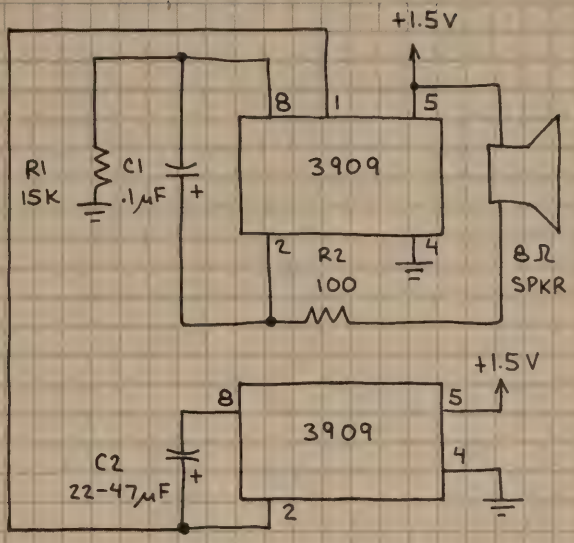


LED FLASHER / OSCILLATOR (CONTINUED)
3909

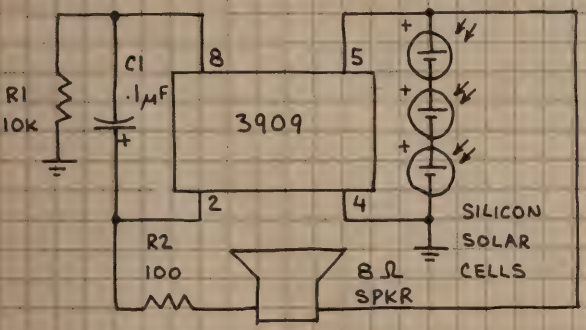
WHOOPER



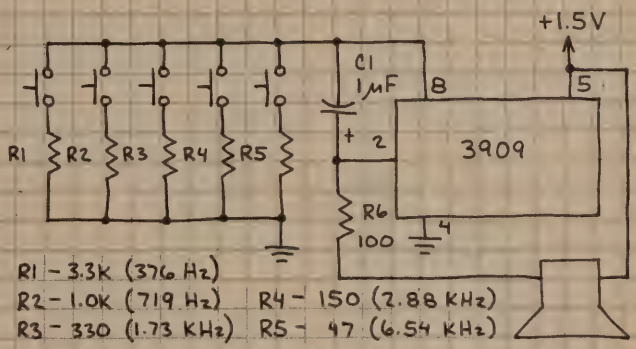
CHIRPER



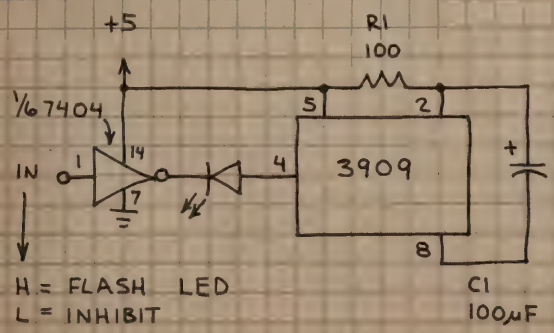
SUN POWERED OSCILLATOR

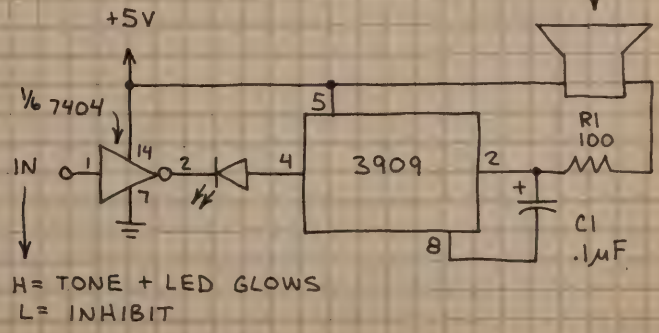


TOY ORGAN



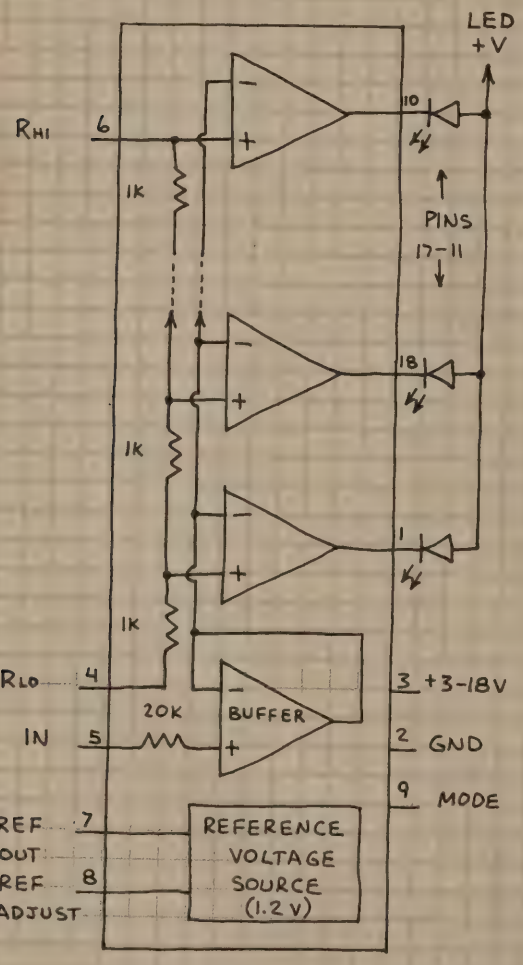
TTL CONTROLLED 3909



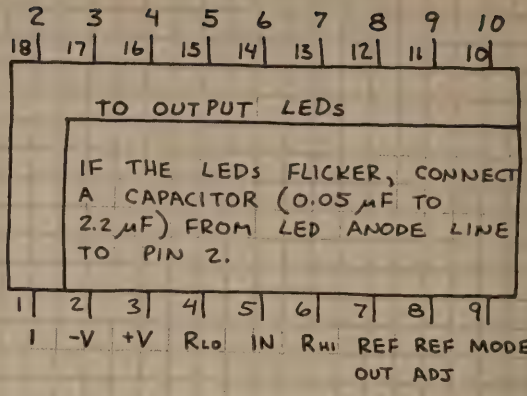


DOT/BAR DISPLAY DRIVER
LM3914N

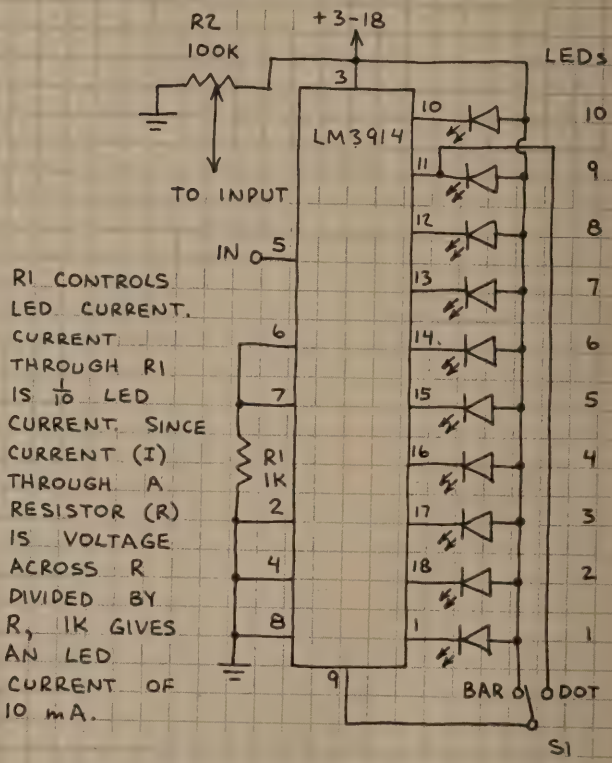
ONE OF THE MOST IMPORTANT CHIPS IN THIS NOTEBOOK. LIGHTS UP TO 10 LEDs (BAR MODE) OR 1-OF-10 LEDs (DOT MODE) IN RESPONSE TO AN INPUT VOLTAGE. CHIP CONTAINS A VOLTAGE DIVIDER AND 10 COMPARATORS THAT TURN ON IN SEQUENCE AS THE INPUT VOLTAGE RISES. HERE'S A SIMPLIFIED VERSION OF THE CIRCUIT:



RHI AND RLO ARE THE ENDS OF THE DIVIDER CHAIN. THE REFERENCE VOLTAGE OUTPUT (REF OUT) IS 1.2-1.3 VOLTS. CONNECT PIN 9 TO PIN 11 FOR DOT MODE OR +V FOR BAR MODE.


2 3 4 5 6 7 8 9 10
18 17 16 15 14 13 12 11 10
TO OUTPUT LEDs
IF THE LEDs FLICKER, CONNECT A CAPACITOR (0.05 μF TO 2.2 μF) FROM LED ANODE LINE TO PIN 2.
1 2 3 4 5 6 7 8 9
I -V +V RLO IN RHI REF OUT REF ADJ MODE

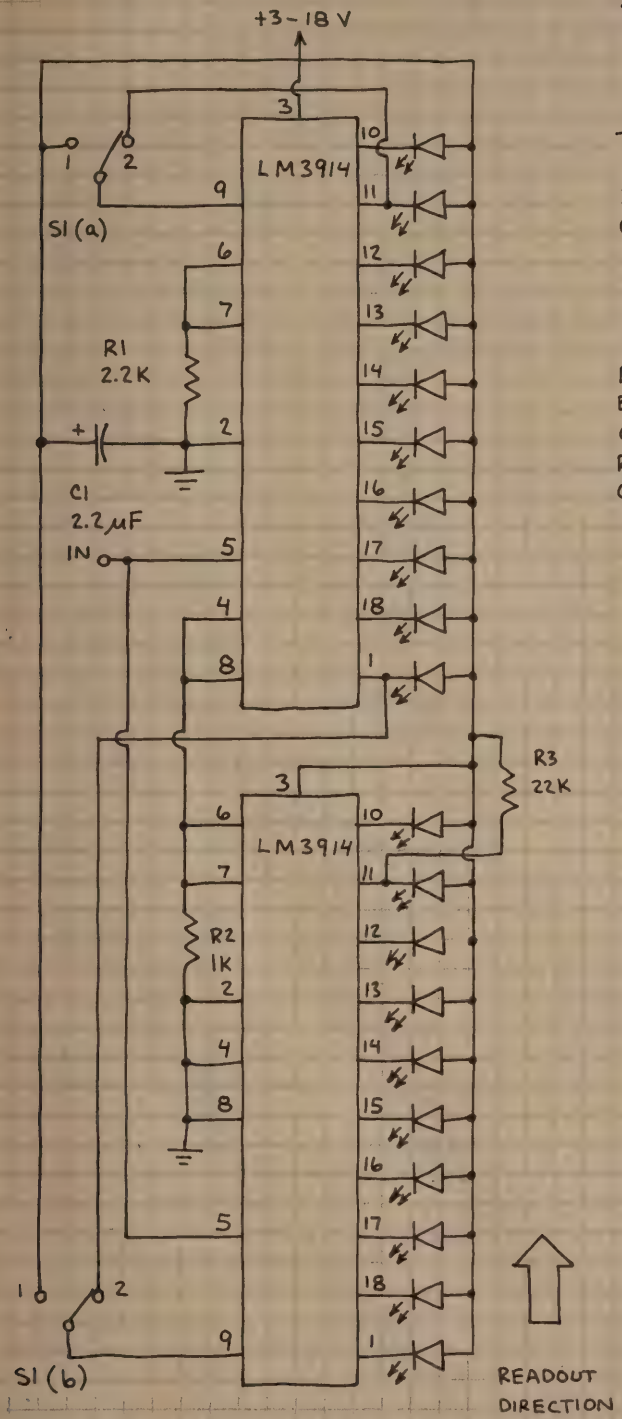
DOT/BAR DISPLAY



R1 CONTROLS LED CURRENT. CURRENT THROUGH R1 IS $\frac{1}{10}$ LED CURRENT. SINCE CURRENT (I) THROUGH A RESISTOR (R) IS VOLTAGE ACROSS R DIVIDED BY R, 1K GIVES AN LED CURRENT OF 10 mA.

WHEN +V = +3-18 VOLTS, THE READOUT RANGE IS 0.13 — 1.30 VOLTS. TO CHANGE RANGE TO 0.1-1.0 VOLT (0.1 VOLT PER LED), INSERT A 5K POTENTIOMETER BETWEEN PINS 6 AND 7. CONNECT VOLTMETER ACROSS PINS 5 AND 8 AND ADJUST R2 FOR 1 VOLT AT PIN 5. THEN ADJUST 1K POT UNTIL LED 10 GLOWS. REPEAT THIS PROCEDURE FOR 0.1 VOLT AT PIN 5 AND LED 1. OK TO REPLACE THE 1K POT WITH A FIXED RESISTOR OF THE PROPER VALUE.

DOT/BAR DISPLAY DRIVER (CONTINUED)
LM3914N

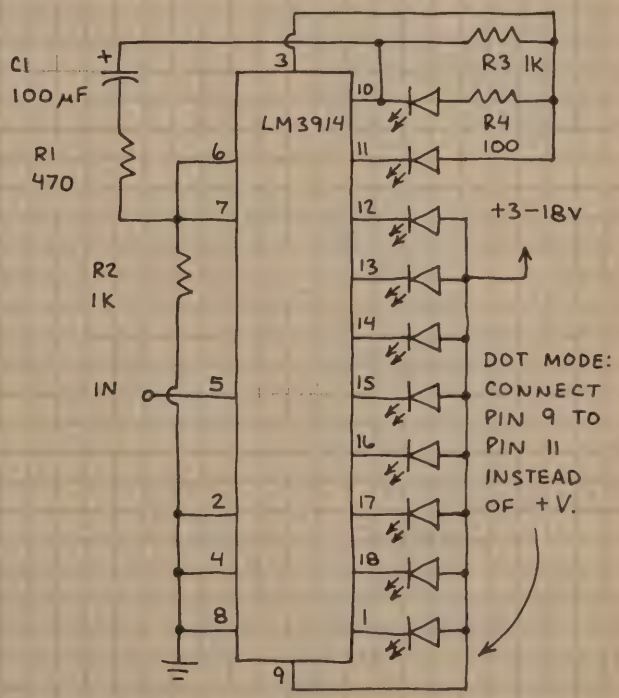


20-ELEMENT READOUT

THIS CIRCUIT SHOWS HOW TO CASCADE 2 OR MORE LM3914's. WHEN +V = 5 VOLTS, THE READOUT RANGE IS 0.14 V TO 2.7 V. HIGHEST ORDER LED STAYS ON DURING OVERRANGE. AVOID SUBSTITUTIONS FOR R1, R2 AND R3.

S1 IS THE MODE SWITCH. USE A DPDT TOGGLE. POSITION 1 SELECTS BAR AND POSITION 2 SELECTS DOT. OMIT S1 IF ONLY ONE MODE IS REQUIRED. SIMPLY WIRE IN THE CORRECT CONNECTIONS.

FLASHING BAR READOUT

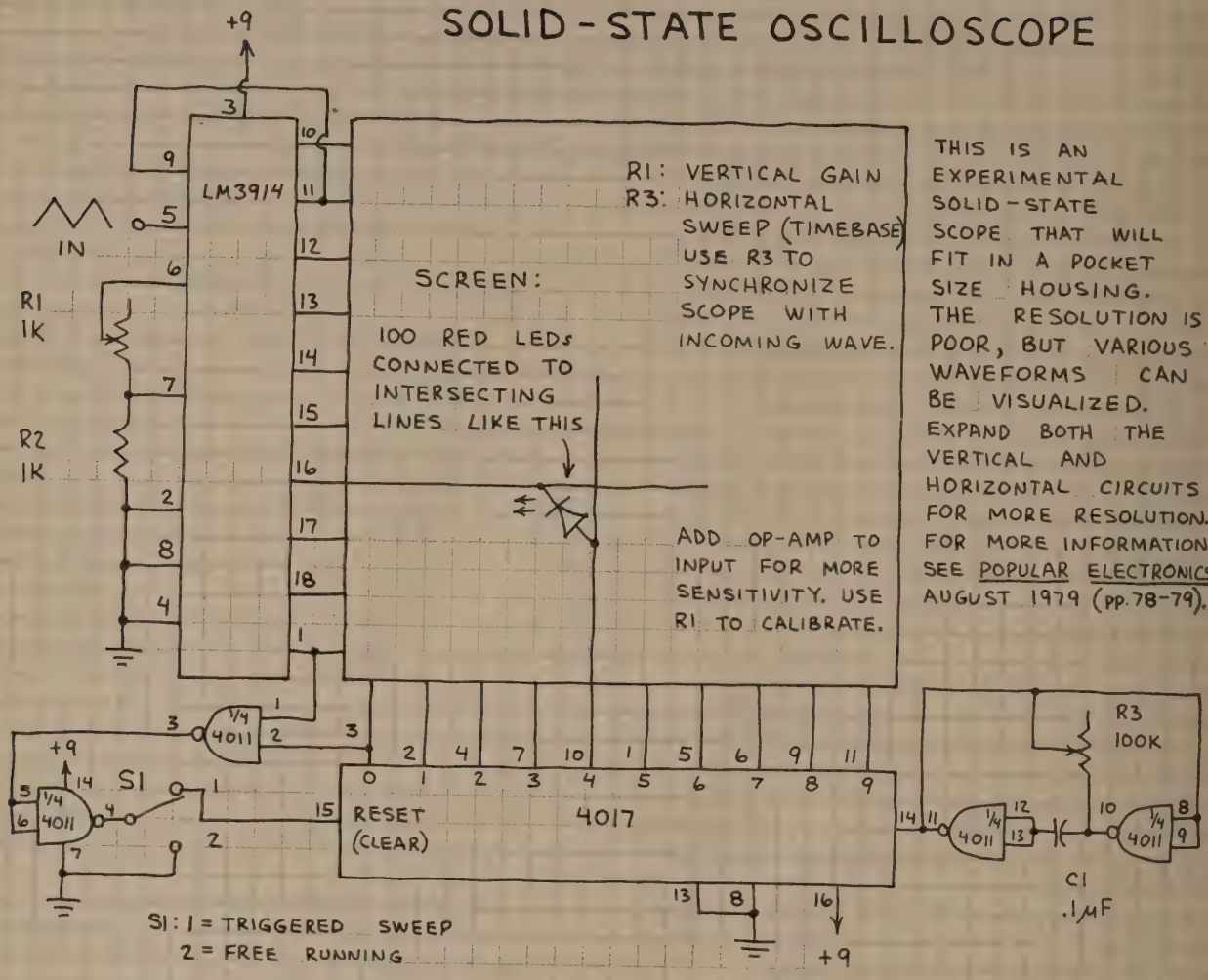


THE CIRCUITS ON THIS PAGE ARE ADAPTED FROM NATIONAL SEMICONDUCTOR'S LM3914 LITERATURE. BOTH WORK WELL.

WHEN ALL 10 LEDs ARE ON THE DISPLAY FLASHES. OTHERWISE THE LEDs DO NOT FLASH. INCREASE C1 TO SLOW FLASH RATE.

DOT/BAR DISPLAY DRIVER (CONTINUED)
LM3914N

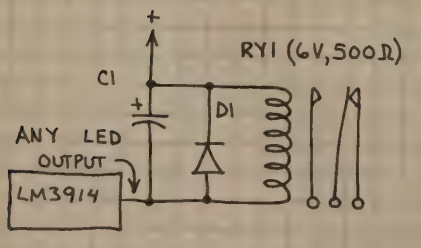
SOLID-STATE OSCILLOSCOPE



THIS IS AN EXPERIMENTAL SOLID-STATE SCOPE THAT WILL FIT IN A POCKET SIZE HOUSING. THE RESOLUTION IS POOR, BUT VARIOUS WAVEFORMS CAN BE VISUALIZED. EXPAND BOTH THE VERTICAL AND HORIZONTAL CIRCUITS FOR MORE RESOLUTION. FOR MORE INFORMATION SEE POPULAR ELECTRONICS, AUGUST 1979 (pp. 78-79).

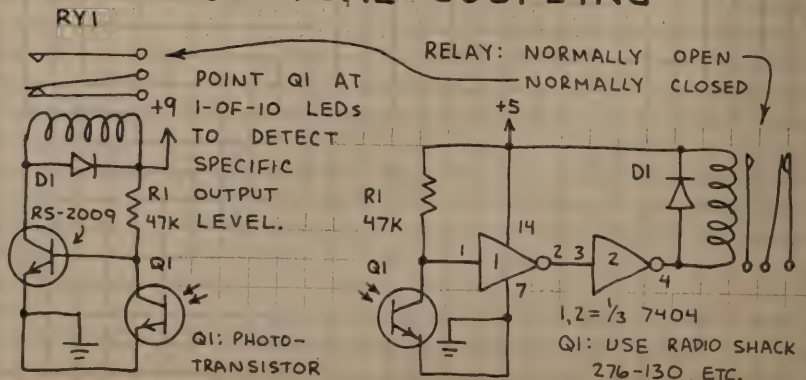
USING THE LM3914 AS A CONTROLLER:

RELAY



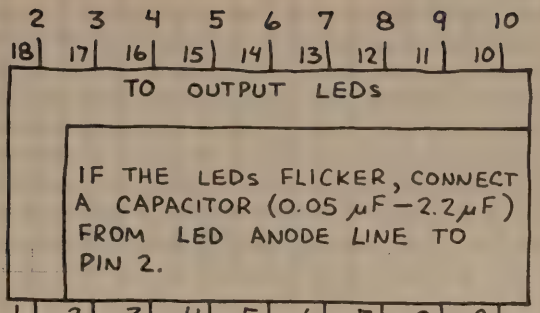
C1 — 47μF (PREVENTS CHATTER)
D1 — IN914
RY1 — RADIO SHACK 275-004

OPTICAL COUPLING



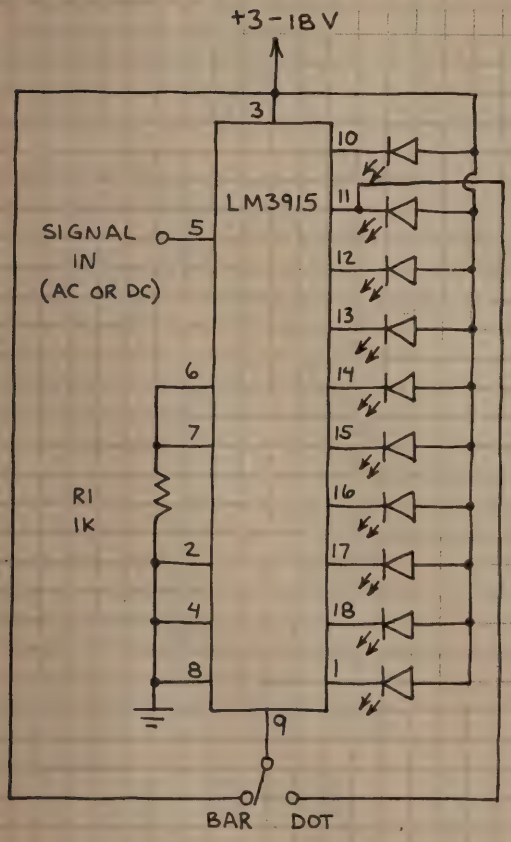
DOT/BAR DISPLAY DRIVER LM3915N

LOGARITHMIC VERSION OF THE LM3914N. THE LM3914N USES A STRING OF 1K RESISTORS AS A VOLTAGE DIVIDER WITH LINEARILY SCALED DIVISIONS. THE VOLTAGE DIVIDER RESISTORS OF THE LM3915N ARE SCALED TO GIVE A -3dB INTERVAL FOR EACH OUTPUT. THIS CHIP IS IDEAL FOR VISUALLY MONITORING THE AMPLITUDE OF AUDIO SIGNALS.


2 3 4 5 6 7 8 9 10
18 17 16 15 14 13 12 11 10
TO OUTPUT LEDs
IF THE LEDs FLICKER, CONNECT A CAPACITOR (0.05 μF – 2.2 μF) FROM LED ANODE LINE TO PIN 2.
1 2 3 4 5 6 7 8 9
1 -V +V RLO IN RHI REF OUT REF ADJ MODE

SEE LM3914N FOR EXPLANATION OF PIN FUNCTIONS.

0 TO -27 dB DOT/BAR DISPLAY



LED DISPLAY

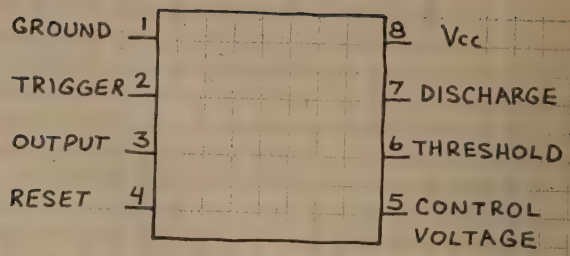
		BAR MODE*
0 dB	(FULLSCALE OR FS)	●●●●●●●●●●
-3 dB	(.707 FS)	●●●●●●●●●○
-6 dB	(.500 FS)	●●●●●●●●○○
-9 dB	(.354 FS)	●●●●●●●○○○
-12 dB	(.250 FS)	●●●●●●○○○○
-15 dB	(.177 FS)	●●●●●○○○○○
-18 dB	(.125 FS)	●●●●○○○○○○
-21 dB	(.088 FS)	●●●○○○○○○○
-24 dB	(.062 FS)	●●○○○○○○○○
-27 dB	(.044 FS)	●○○○○○○○○○

* OK TO USE DOT MODE.

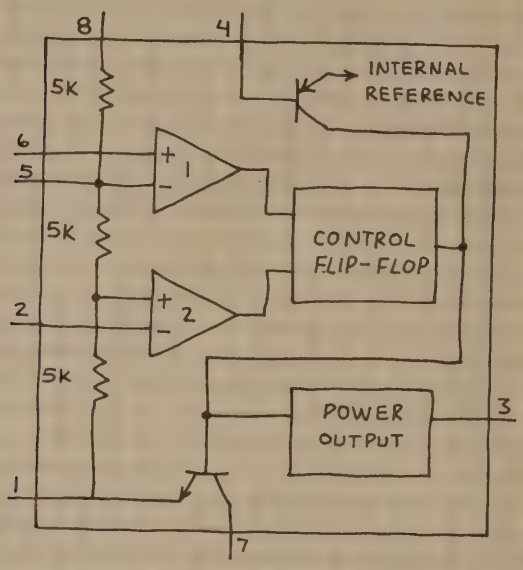
THE INPUT SIGNAL CAN BE CONNECTED DIRECTLY TO PIN 5 WITHOUT RECTIFICATION, LIMITING OR AC COUPLING. SEE THE LM3914N FOR MORE IDEAS AND TIPS.

TIMER
555

THE FIRST AND STILL THE MOST POPULAR IC TIMER CHIP. OPERATES AS A ONE-SHOT TIMER OR AN ASTABLE MULTIVIBRATOR. THE 556 IS TWO 555 CIRCUITS ON ONE CHIP.

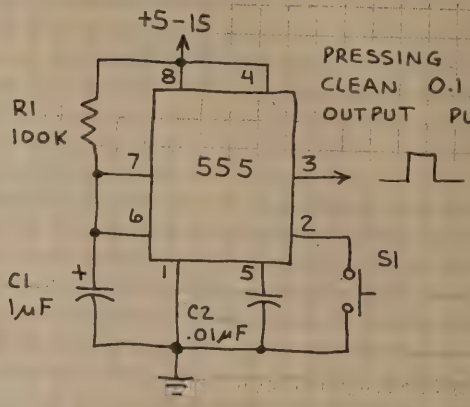


555 EQUIVALENT CIRCUIT

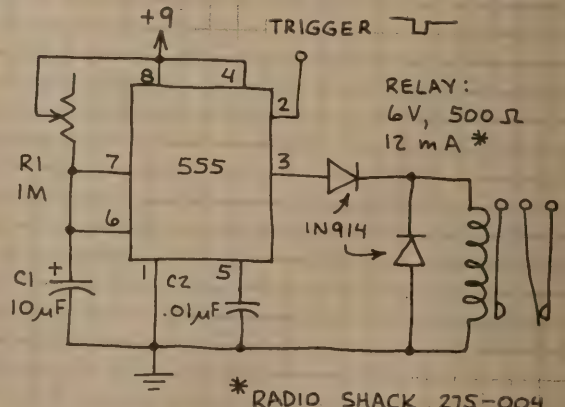


1 AND 2 ARE COMPARATORS. CIRCUIT CAN BE MADE FROM INDIVIDUAL PARTS AS SHOWN... BUT 555 IS MUCH SIMPLER.

BOUNCELESS SWITCH



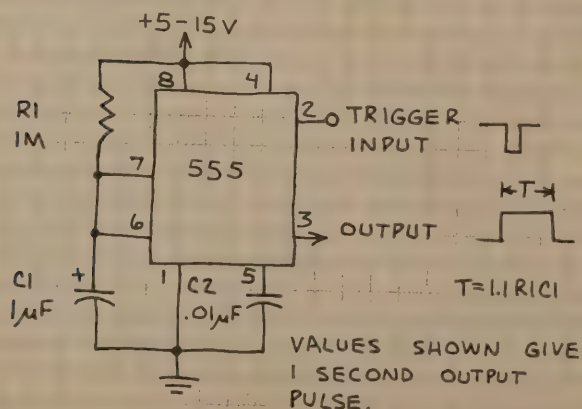
TIMER PLUS RELAY



*RADIO SHACK 275-004

VALUES OF R1 AND C1 SHOWN WILL PULL RELAY IN FOR UP TO ABOUT 11 SECONDS. USE POINTER KNOB AND PAPER SCALE TO HELP CALIBRATE CIRCUIT. USES INCLUDE DARKROOM TIMING. CIRCUIT CAN BE TRIGGERED BY A NEGATIVE PULSE OR WITH A PUSHBUTTON SWITCH ACROSS PINS 1 AND 2.

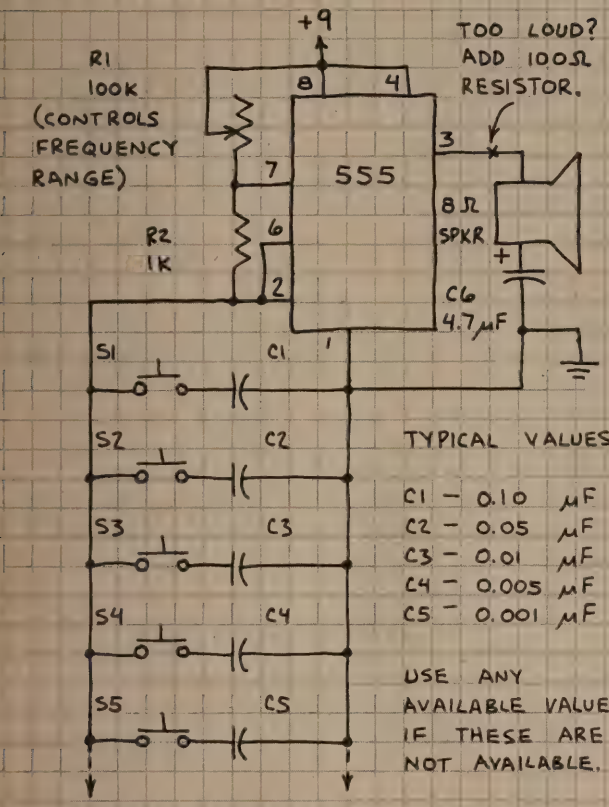
ONE-SHOT TIMER



VALUES SHOWN GIVE 1 SECOND OUTPUT PULSE.

TIMER (CONTINUED)
555

TOY ORGAN



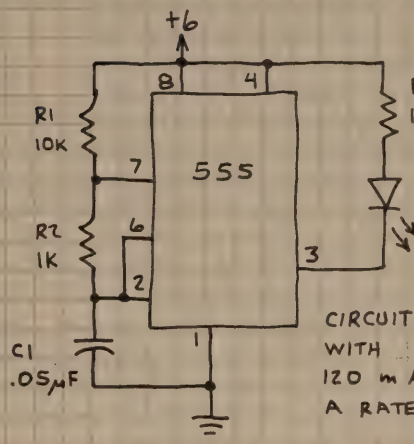
TYPICAL VALUES:

C1 – 0.10 μF
C2 – 0.05 μF
C3 – 0.01 μF
C4 – 0.005 μF
C5 – 0.001 μF

USE ANY AVAILABLE VALUES IF THESE ARE NOT AVAILABLE.

ADD ADDITIONAL STAGES IF DESIRED. SWITCHES ARE NORMALLY OPEN PUSHBUTTONS.

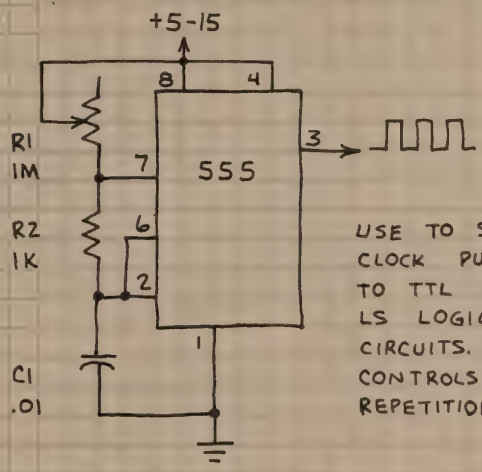
LED TRANSMITTER



USE INFRARED LED FOR BEST RESULTS.

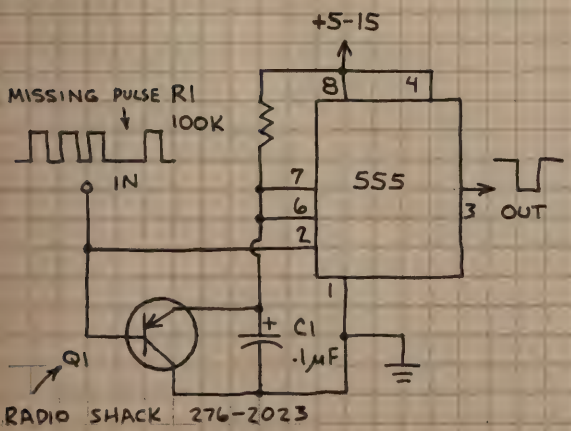
CIRCUIT PULSES LED WITH 45 μSEC LONG, 120 mA PULSES AT A RATE OF 4.8 KHz.

PULSE GENERATOR



USE TO SUPPLY CLOCK PULSES TO TTL AND LS LOGIC CIRCUITS. R1 CONTROLS PULSE REPETITION RATE.

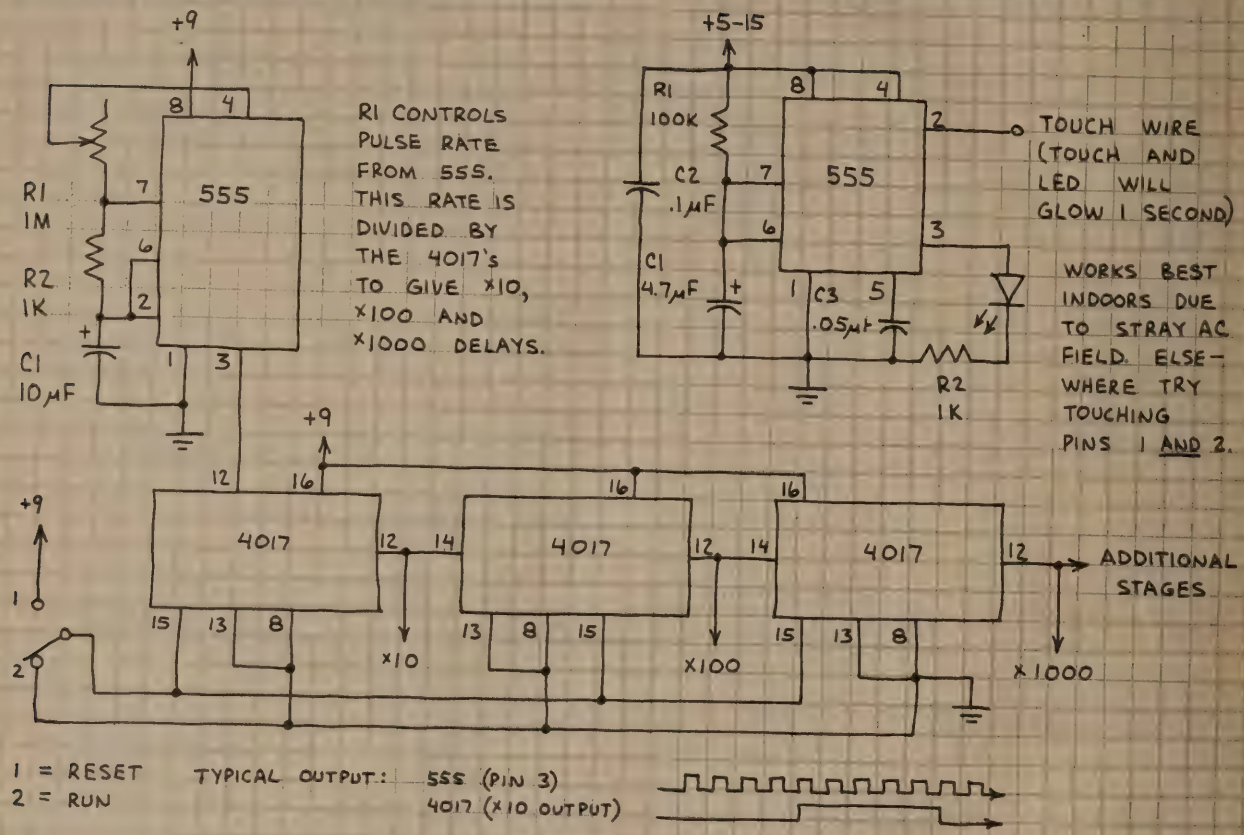
MISSING PULSE DETECTOR



THIS CIRCUIT IS A ONE-SHOT THAT IS CONTINUALLY RETRIGGERED BY INCOMING PULSES. A MISSING OR DELAYED PULSE THAT PREVENTS RETRIGGERING BEFORE A TIMING CYCLE IS COMPLETE CAUSES PIN 3 TO GO LOW UNTIL A NEW INPUT PULSE ARRIVES. R1 AND C1 CONTROL RESPONSE TIME. USE IN SECURITY ALARMS, CONTINUITY TESTERS, ETC.

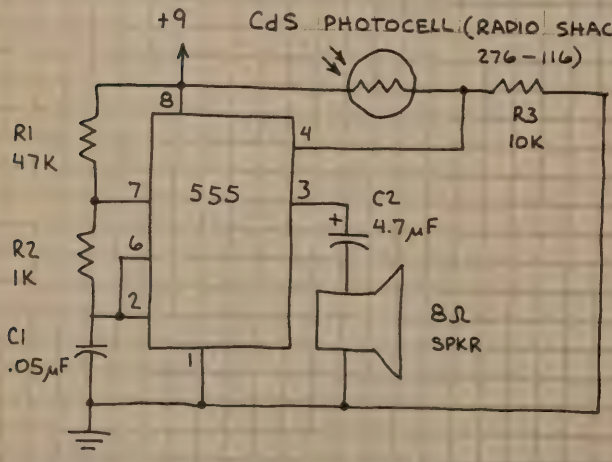
TIMER (CONTINUED)
555

ULTRA-LONG TIME DELAY



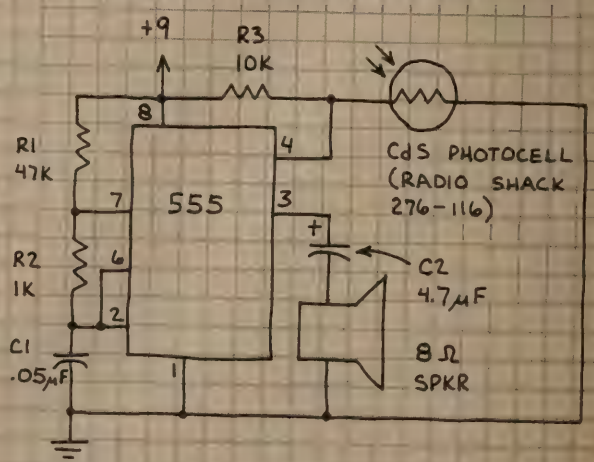
TOUCH SWITCH

LIGHT DETECTOR



PRODUCES WARNING TONE WHEN LIGHT STRIKES PHOTOCELL. MAKES A GOOD OPEN DOOR ALARM FOR REFRIGERATOR OR FREEZER.

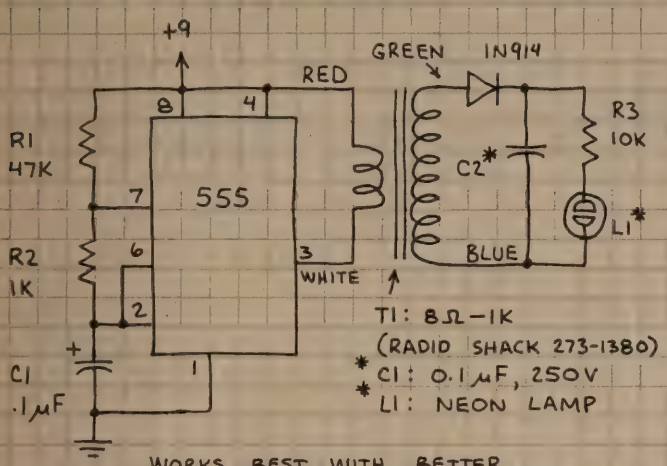
DARK DETECTOR



SILENT WHEN LIGHT STRIKES PHOTOCELL. REMOVE LIGHT AND TONE SOUNDS. FASTER RESPONSE THAN ADJACENT CIRCUIT.

TIMER (CONTINUED)
555

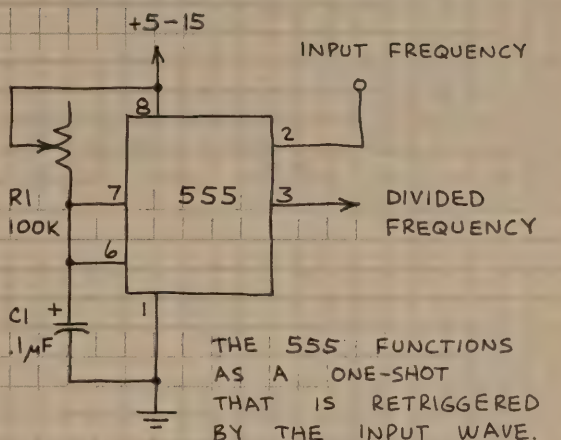
NEON LAMP POWER SOURCE



T1: 8Ω–1K
(RADID SHACK 273-1380)
* C1: 0.1μF, 250V
* L1: NEON LAMP

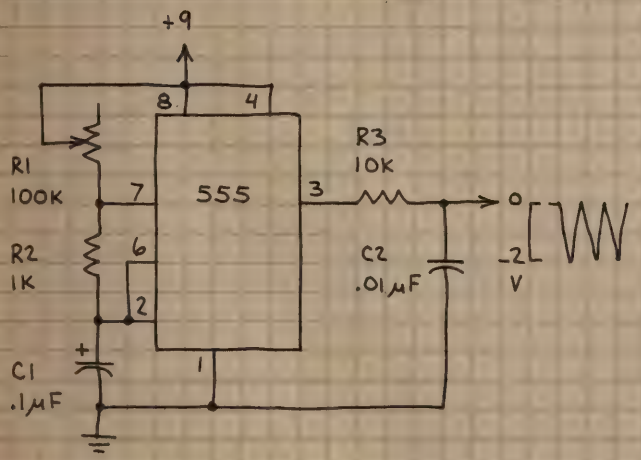
WORKS BEST WITH BETTER QUALITY NEON LAMPS. REDUCE R1 SLIGHTLY FOR MORE OUTPUT VOLTAGE.

FREQUENCY DIVIDER



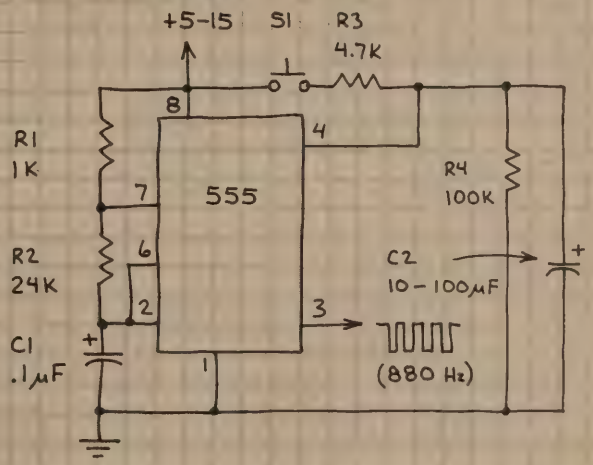
THE 555 FUNCTIONS AS A ONE-SHOT THAT IS RETRIGGERED BY THE INPUT WAVE. WAVES ARRIVING DURING THE TIMING CYCLE ARE IGNORED.

TRIANGLE WAVE GENERATOR



ADJUST R1 TO PROVIDE UP TO 10 KHz. OUTPUT FREQUENCY THIS HIGH PRODUCES CLOSELY SPACED TRIANGLE WAVES. THE WAVES ARE SEPARATED AT SLOWER FREQUENCIES ( ).

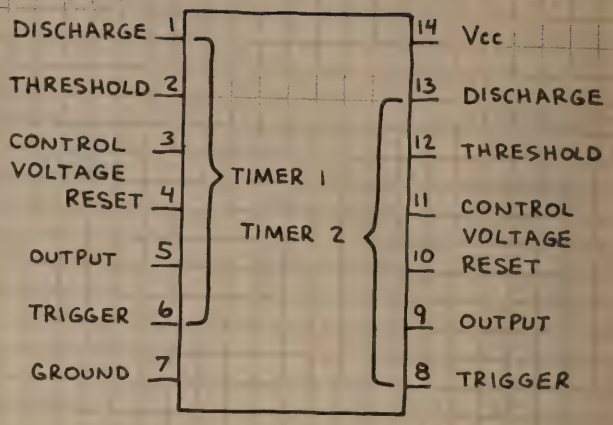
ONE-SHOT TONE BURST



PRESS S1 AND STEADY OUTPUT FREQUENCY APPEARS AT PIN 3. RELEASE S1 AND OUTPUT FREQUENCY CONTINUES UNTIL C2 IS DISCHARGED BY R4. INCREASE C2 (OR R4) TO INCREASE LENGTH OF THE BURST. CHANGE FREQUENCY OF TONE BURST VIA R2 OR C1.

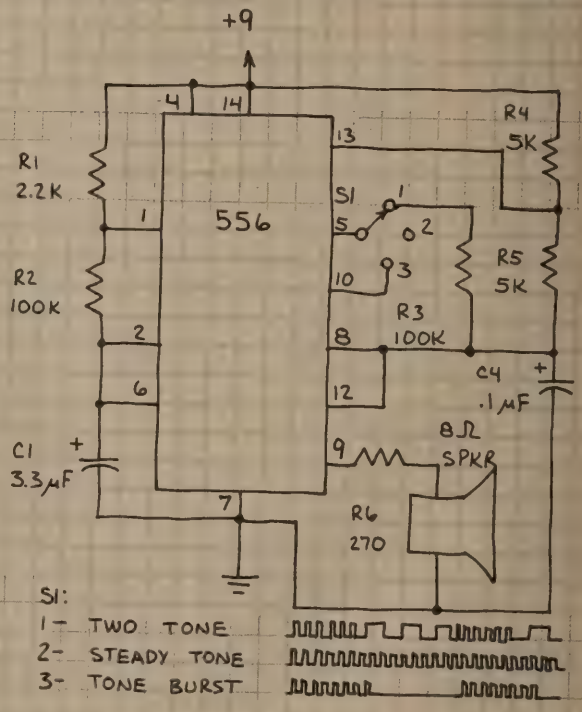
DUAL TIMER
556

CONTAINS TWO INDEPENDENT TIMERS ON A SINGLE CHIP. BOTH TIMERS ARE IDENTICAL TO THE 555. ALL THE APPLICATION CIRCUITS CAN ALSO BE BUILT WITH TWO 555's. THIS PIN CROSS REFERENCE WILL SIMPLIFY SUBSTITUTING TWO 555's FOR A 556 OR HALF A 556 FOR A 555:

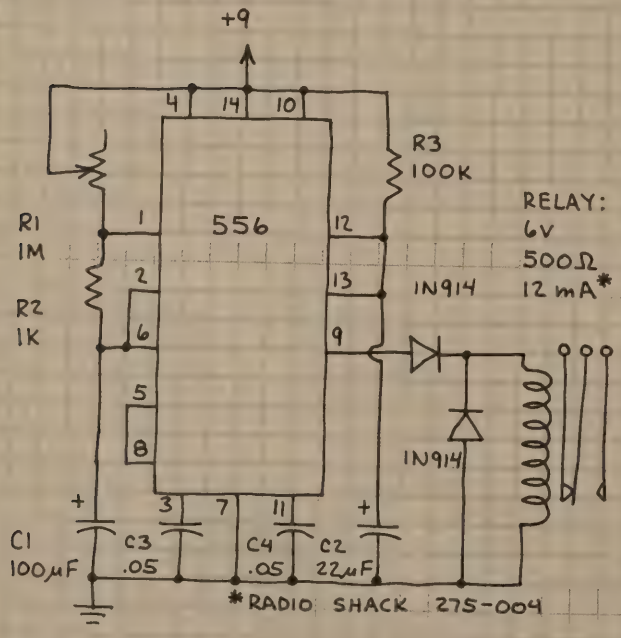


FUNCTION	555	556(1)	556(2)
GROUND	1	7	7
TRIGGER	2	6	8
OUTPUT	3	5	9
RESET	4	4	10
CONTROL V.	5	3	11
THRESHOLD	6	2	12
DISCHARGE	7	1	13
Vcc	8	14	14

3-STATE TONE SOURCE

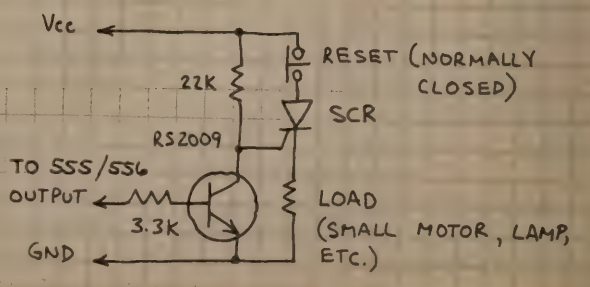


INTERVAL TIMER



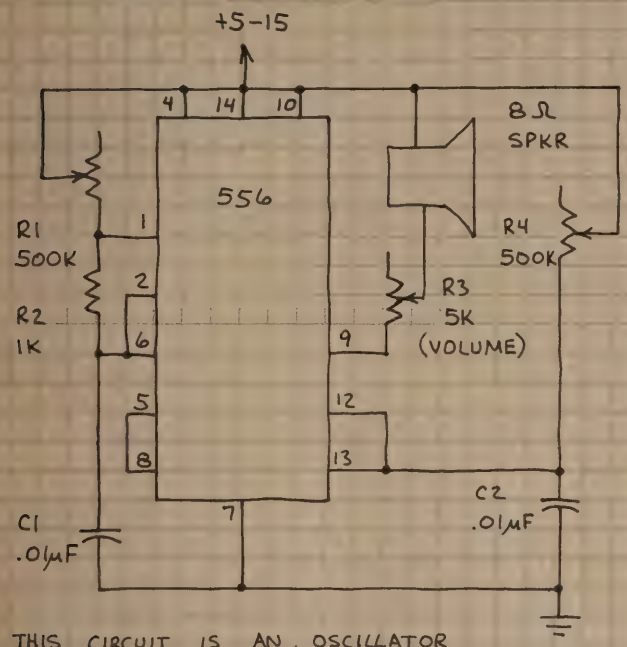
TIMER 1 IS CONNECTED AS ASTABLE OSCILLATOR. TIMER 2 IS A ONE-SHOT RELAY DRIVER. 1 FIRES 2 ONCE EACH CYCLE. 2 PULLS RELAY IN FOR 3-5 SECONDS.

555/556 SCR OUTPUT



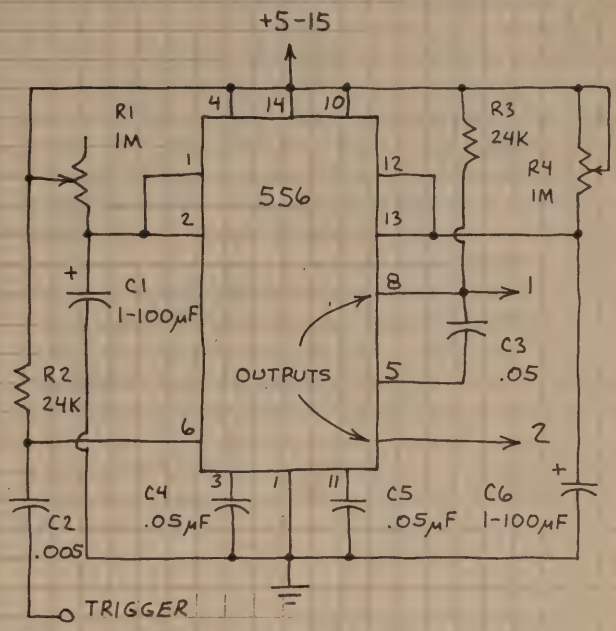
DUAL TIMER (CONTINUED)
556

SOUND SYNTHESIZER



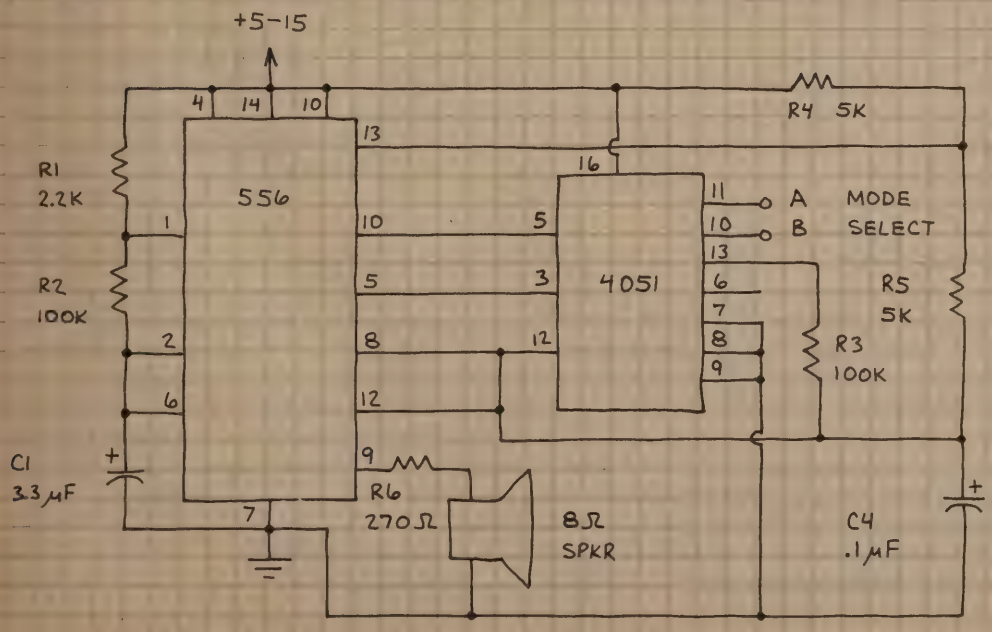
THIS CIRCUIT IS AN OSCILLATOR FOLLOWED BY A FREQUENCY DIVIDER. ADJUST R1 AND R4 FOR VERY UNUSUAL SOUND EFFECTS.

TWO-STAGE TIMER



BOTH TIMERS ARE IN ONE-SHOT MODE. GROUNDING THE TRIGGER INPUT INITIATES THE FIRST TIMER'S CYCLE TIME. THE SECOND TIMER'S CYCLE BEGINS AFTER THE FIRST IS COMPLETE.

PROGRAMMABLE 4-STATE TONE GENERATOR



MODE SELECT

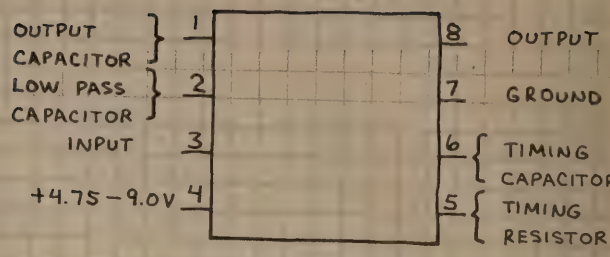
B A	OUTPUT
L L	TWO-TONE
L H	STEADY
H L	BURST
H H	METRONOME

L = GND
H = +5-15 (V_{DD})

CHANGE C1 AND C4 TO ALTER THE OUTPUT TONES.

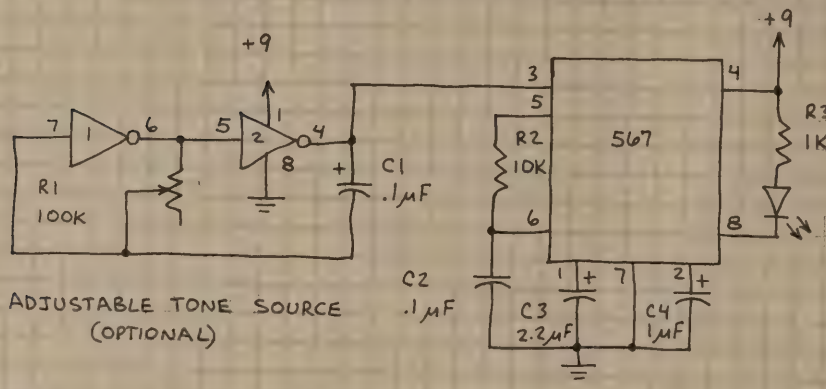
TONE DECODER
567

CONTAINS A PHASE-LOCKED LOOP. PIN 8 GOES LOW WHEN THE INPUT FREQUENCY MATCHES THE CHIP'S CENTER FREQUENCY (f_o). THE LATTER FREQUENCY IS SET BY THE TIMING RESISTOR AND CAPACITOR (R AND C) AND IS $(1.1) \div (RC)$. R SHOULD BE BETWEEN 2K-20K. THE 567 CAN BE ADJUSTED TO DETECT ANY INPUT BETWEEN 0.01 Hz TO 500KHz. NOTE: 1 SECOND OR MORE MAY BE REQUIRED FOR THE 567 TO LOCK ON TO LOW FREQUENCY INPUTS! SEE THIS CHIP'S SPECIFICATIONS FOR MORE INFORMATION.



THE VALUE IN MICROFARADS OF THE LOW PASS CAPACITOR SHOULD BE n / f_o WHERE n RANGES BETWEEN 1300 (FOR UP TO 14% f_o DETECTION BANDWIDTH) TO 62,000 (UP TO 2% f_o DETECTION BANDWIDTH). THE OUTPUT CAPACITOR SHOULD HAVE ABOUT TWICE THE CAPACITANCE OF THE LOW PASS FILTER CAPACITOR.

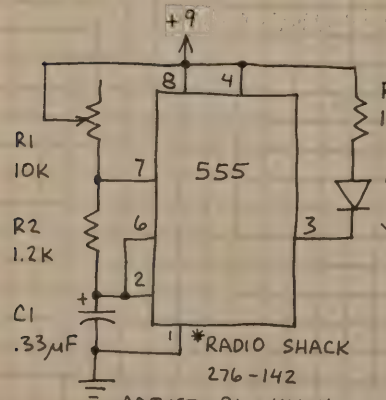
BASIC TONE DETECTOR CIRCUIT



THIS CIRCUIT IS HANDY FOR LEARNING TONE DECODER BASICS. THE 567 PORTION CAN BE USED IN MANY DIFFERENT APPLICATIONS (SEE BELOW). THE PREDICTED f_o IS 1.1 KHz. THE TEST CIRCUIT f_o WAS 1.3KHz.

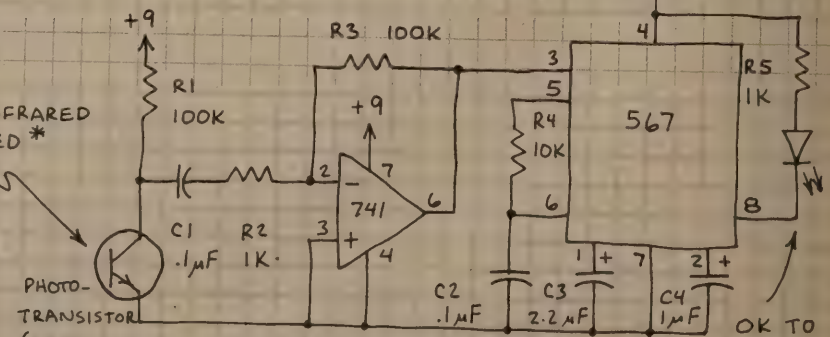
INFRARED REMOTE CONTROL SYSTEM

TRANSMITTER



ADJUST R1 UNTIL RECEIVER LED GLOWS.

RECEIVER



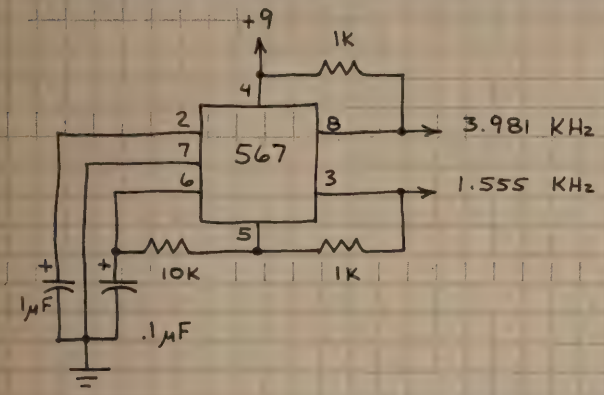
RANGE: SEVERAL INCHES. USE LENSES TO INCREASE.

OK TO USE 6V RELAY.

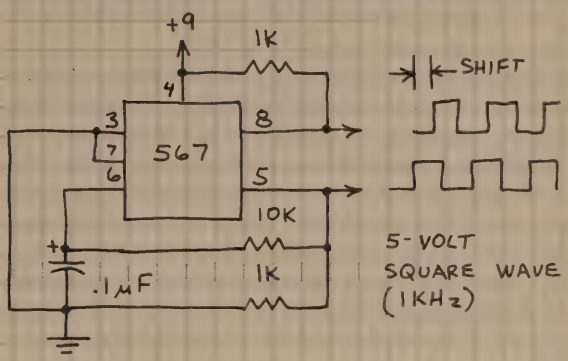
TONE DECODER (CONTINUED)

567

2-FREQUENCY OSCILLATOR



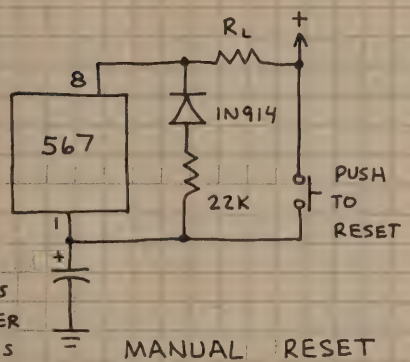
2-PHASE OSCILLATOR



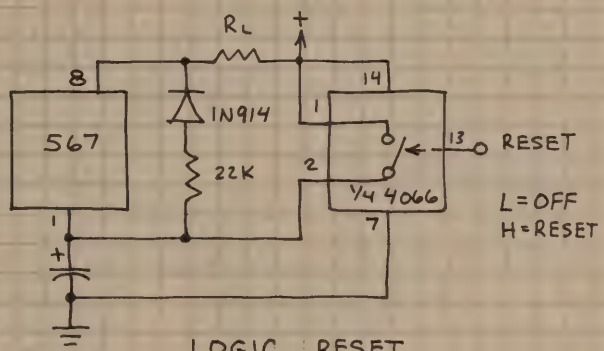
LATCHING THE 567 OUTPUT *

BOTH CIRCUITS SHOW ONLY THE LATCH COMPONENTS. R_L IS THE LOAD (LED, RELAY, ETC.).

*OUTPUT STAYS ON EVEN AFTER INPUT TONE IS REMOVED.

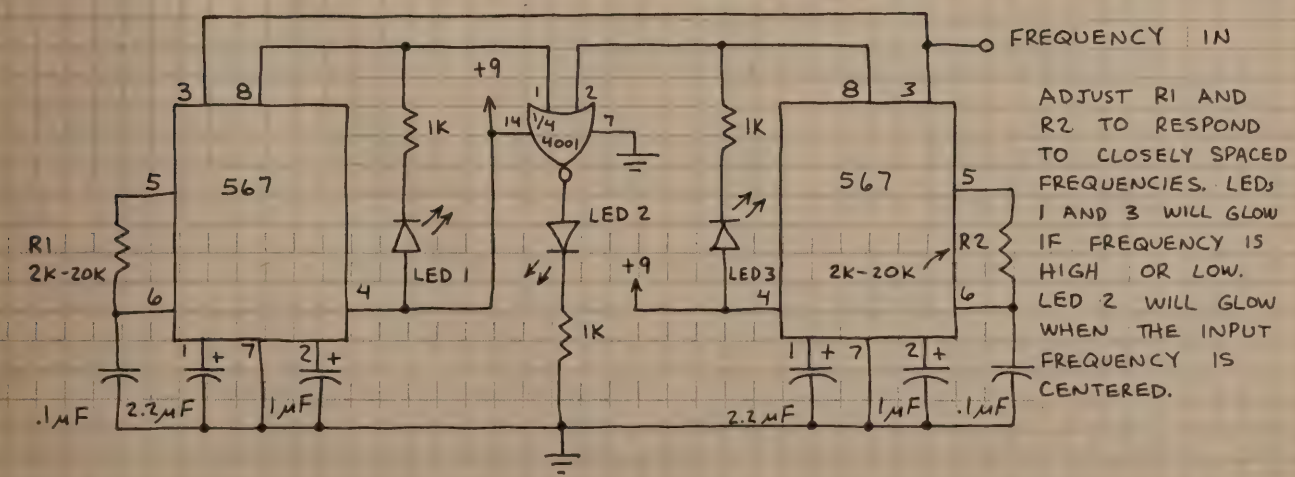


MANUAL RESET



LOGIC RESET

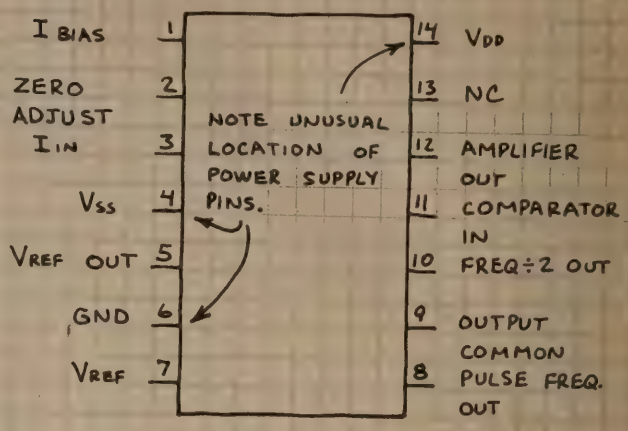
NARROW BAND FREQUENCY DETECTOR



ADJUST R1 AND R2 TO RESPOND TO CLOSELY SPACED FREQUENCIES. LEDs 1 AND 3 WILL GLOW IF FREQUENCY IS HIGH OR LOW. LED 2 WILL GLOW WHEN THE INPUT FREQUENCY IS CENTERED.

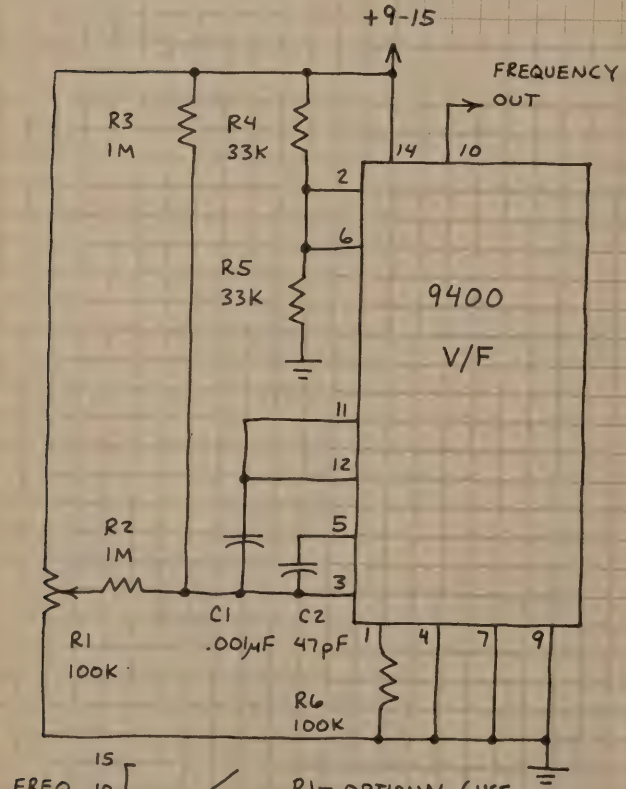
VOLTAGE-TO-FREQUENCY FREQUENCY-TO-VOLTAGE CONVERTER 9400 (276-1790)

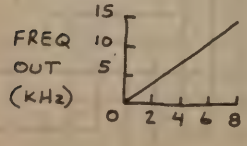
IN VOLTAGE-TO-FREQUENCY (V-F) MODE, AN INPUT VOLTAGE WHICH HAS BEEN CONVERTED INTO A CURRENT BY A RESISTOR AT PIN 3 IS TRANSFORMED INTO A PROPORTIONAL FREQUENCY. IN FREQUENCY-TO-VOLTAGE MODE A FREQUENCY AT PIN 11 IS CONVERTED INTO A PROPORTIONAL VOLTAGE. THIS CHIP CAN BE OPERATED FROM A SINGLE OR DUAL POLARITY POWER SUPPLY.



CAUTION: THIS CHIP INCORPORATES BOTH BIPOLAR AND CMOS CIRCUITRY. THEREFORE CMOS HANDLING PRECAUTIONS MUST BE FOLLOWED TO AVOID PERMANENT DAMAGE.

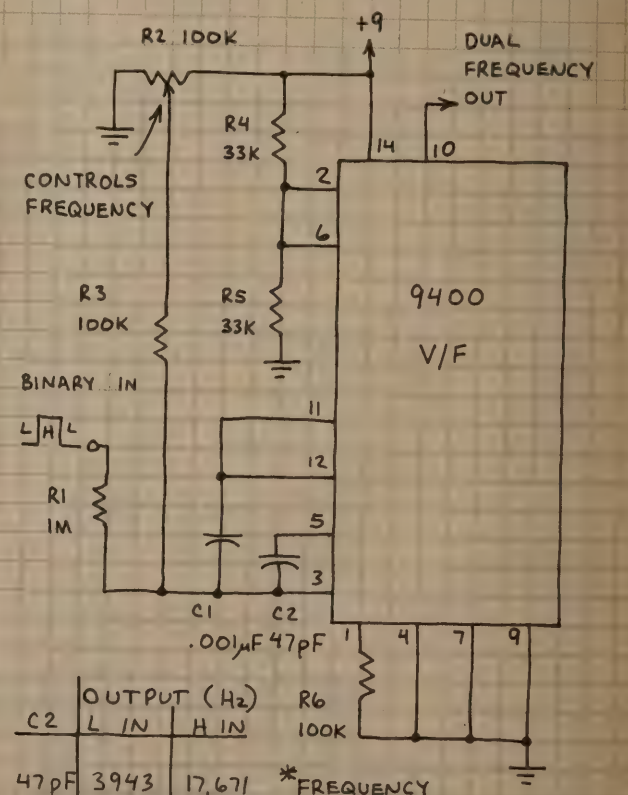
BASIC V/F CONVERTER





R1- OPTIONAL (USE TO SUPPLY INPUT VOLTAGE DURING TESTS).

FSK* DATA TRANSMITTER



C2	OUTPUT (Hz) L IN	H IN
47pF	3943	17,671
.1μF	1000	1665

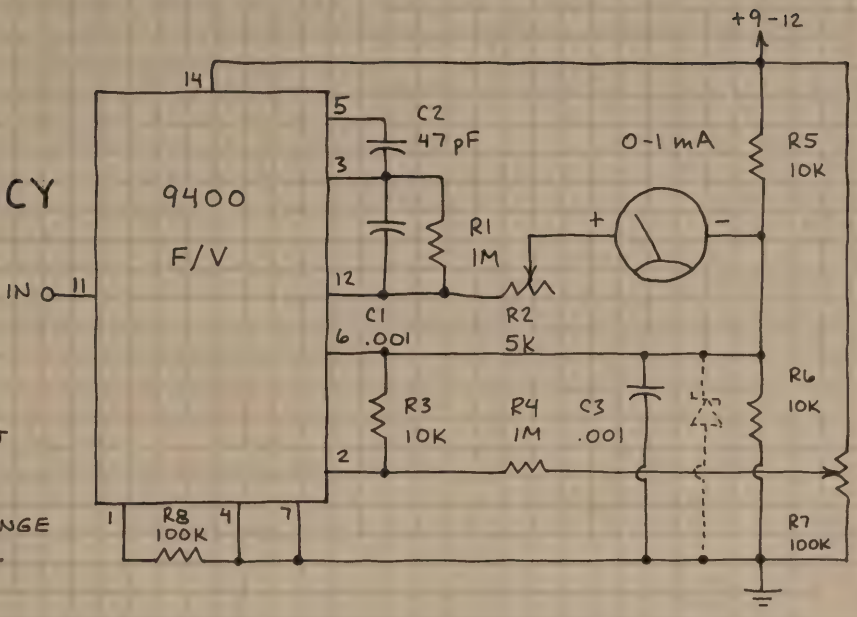
R2 CONTROLS OUTPUT.

*FREQUENCY SHIFT KEYING. USE TO SEND BINARY OVER WIRE OR RADIO.

VOLTAGE-TO-FREQUENCY (CONTINUED)
FREQUENCY-TO-VOLTAGE CONVERTER
9400

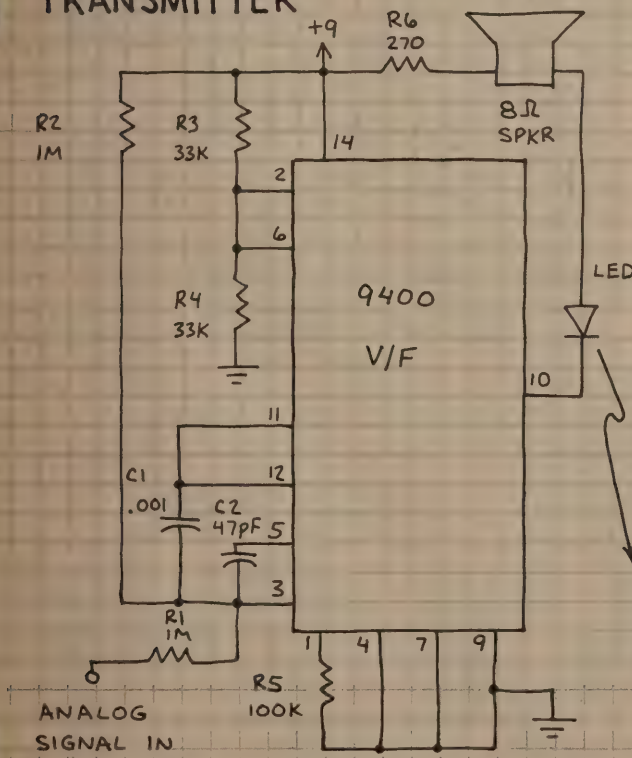
AUDIO FREQUENCY METER

INPUT FREQUENCY MUST CROSS 0 VOLT. WORKS UP TO 25 KHz. R7 IS ZERO ADJUST FOR METER. ADJUST R5 TO GIVE MAXIMUM READING AT 25 KHz IN. FOR MORE STABILITY, CHANGE R6 TO 6-V ZENER DIODE.

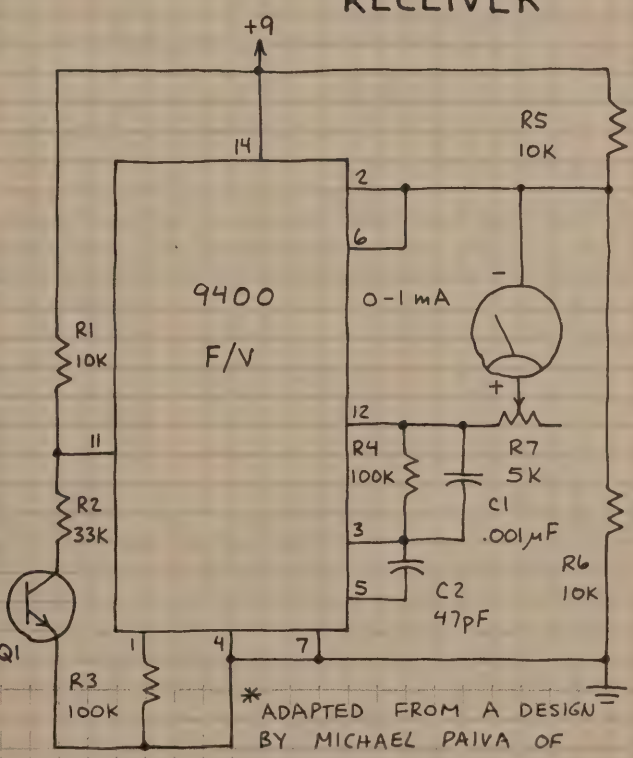


ANALOG DATA TRANSMISSION SYSTEM*

TRANSMITTER



RECEIVER

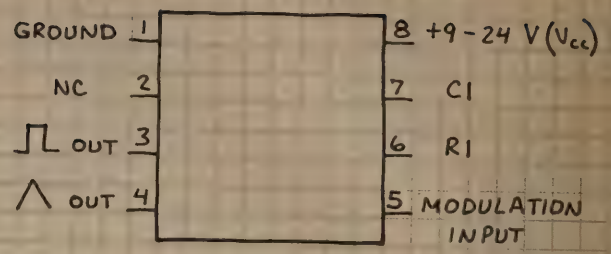


*ADAPTED FROM A DESIGN BY MICHAEL PAIVA OF TELEDYNE.

THE SPKR IS OPTIONAL BUT MAY PROVE HELPFULL DURING INITIAL TESTING. USE AN INFRARED LED (RADIO SHACK 276-142). Q1 CAN BE THE PHOTOTRANSISTOR SUPPLIED WITH THE LED OR RADIO SHACK 276-130. R7 IN THE RECEIVER IS ZERO ADJUST.

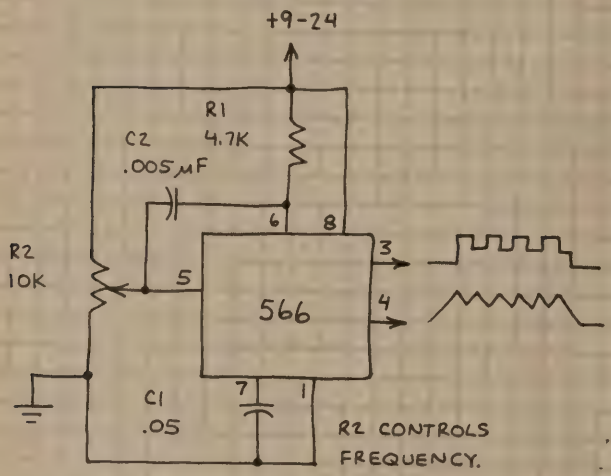
VOLTAGE CONTROLLED OSCILLATOR (VCO) 566

VERY STABLE, EASY TO USE TRIANGLE AND SQUARE WAVE OUTPUTS. R1 AND C1 CONTROL CENTER FREQUENCY. VOLTAGE AT PIN 5 VARIES FREQUENCY. IMPORTANT: OUTPUT WAVE DOES NOT FALL TO 0 VOLT! AT 12 VOLTS (PIN 8), FOR EXAMPLE, TRIANGLE OUTPUT CYCLES BETWEEN +4 AND +6 VOLTS. SQUARE OUTPUT CYCLES BETWEEN +6 AND +11.5 VOLTS.

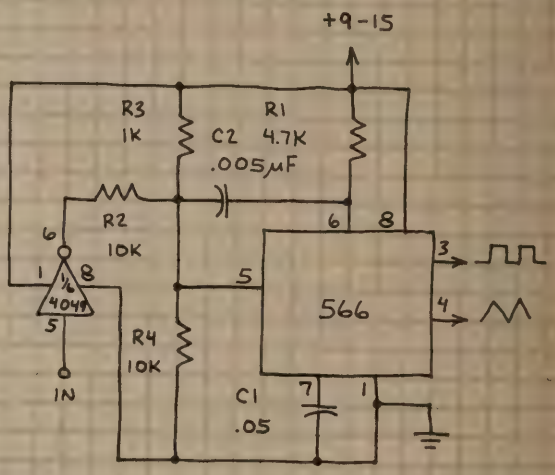


$$\text{CENTER FREQUENCY} = \frac{2\,(V_{cc} - \text{INPUT VOLTS})}{R1\ C1\ V_{cc}}$$

FUNCTION GENERATOR



FSK GENERATOR *



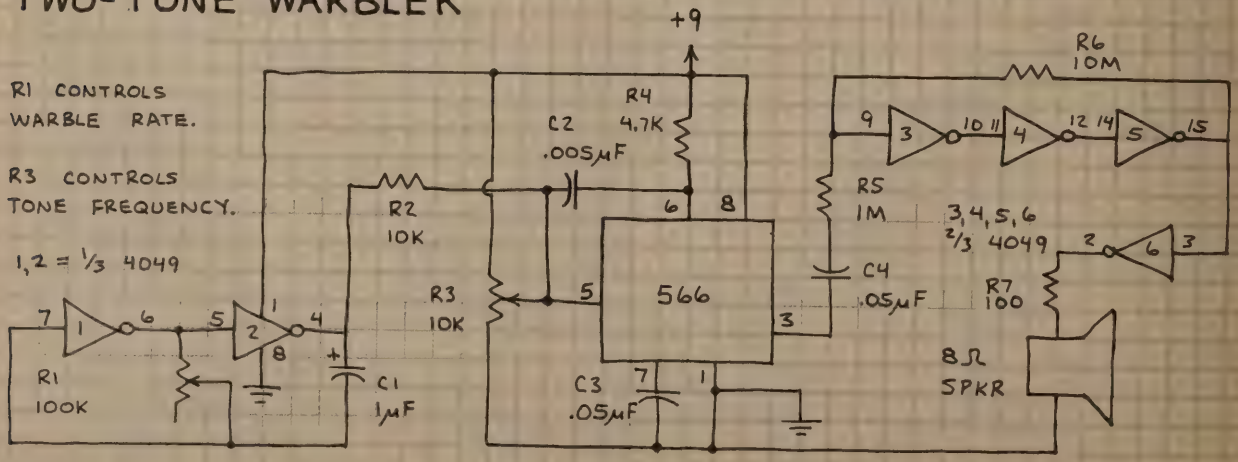
* FSK MEANS FREQUENCY SHIFT KEYING.

IN	OUTPUT
L	1.5 KHz
H	3.0 KHz

USE TO TRANSMIT BINARY DATA OVER TELEPHONE LINES OR STORE BINARY DATA ON MAGNETIC TAPE.

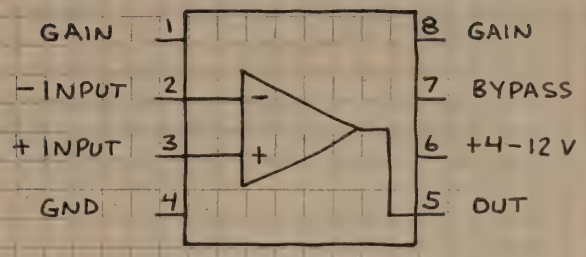
V_{cc} = 9 VOLTS.

TWO-TONE WARBLER

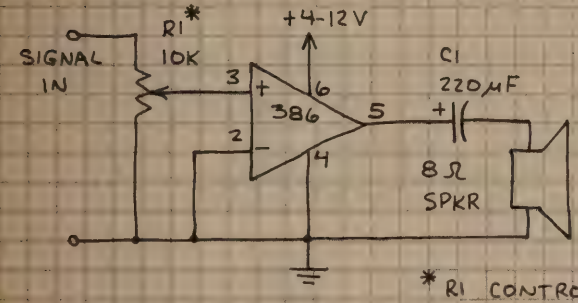


POWER AMPLIFIER
LM386

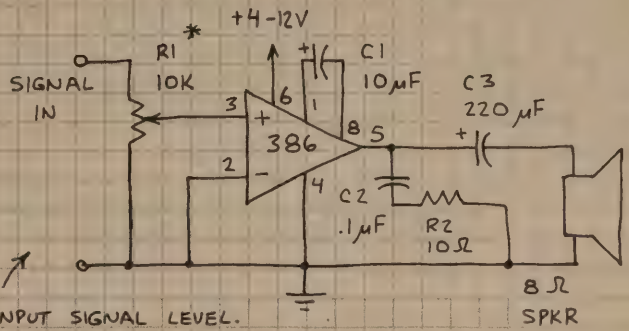
DESIGNED MAINLY FOR LOW VOLTAGE AMPLIFICATION. WILL DRIVE DIRECTLY AN 8-OHM SPEAKER. GAIN FIXED AT 20 BUT CAN BE INCREASED TO ANY VALUE UP TO 200.



X20 AMPLIFIER

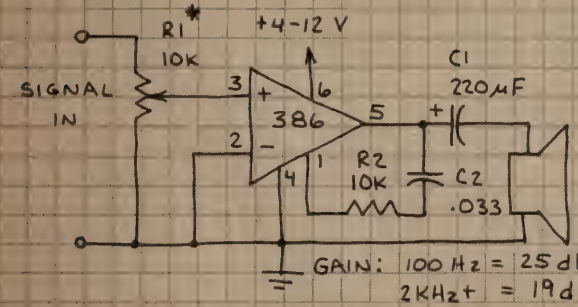


X200 AMPLIFIER



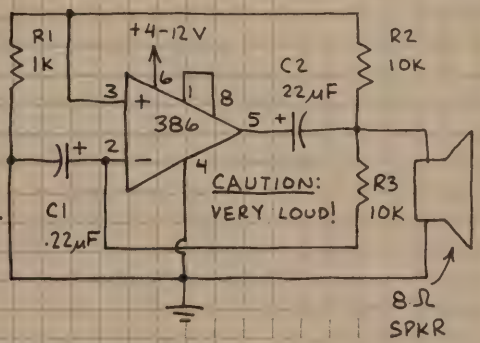
* R1 CONTROLS INPUT SIGNAL LEVEL.

BASS BOOSTER



AUDIBLE ALARM

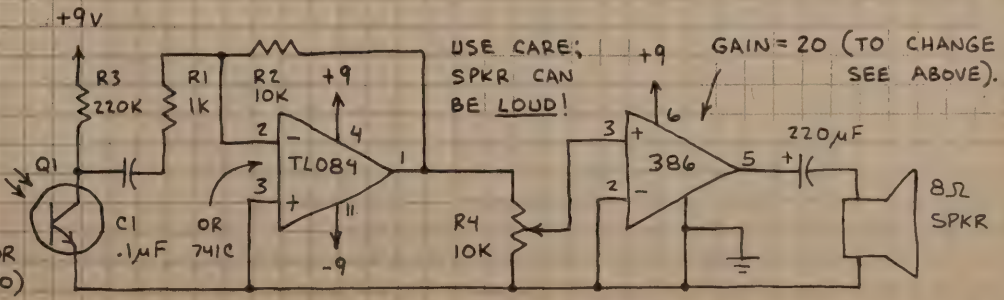
TONE FREQ: 2.1 KHz. REDUCE C1 TO INCREASE FREQUENCY.



HIGH GAIN POWER AMPLIFIER

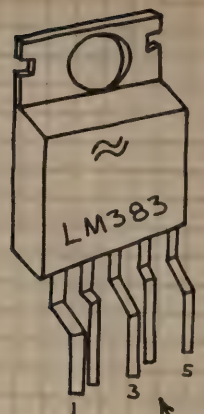
CIRCUIT SHOWN IS VERY SENSITIVE LIGHT WAVE RECEIVER. OK TO USE OTHER OP-AMPS FOR THE TL084.

Q1 - PHOTOTRANSISTOR (RADIO SHACK 276-130)

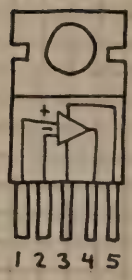


8-WATT POWER AMPLIFIER
LM383 / TDA2002

POWER AMPLIFIER DESIGNED SPECIFICALLY FOR AUTOMOTIVE APPLICATIONS — BUT IDEAL FOR ANY AUDIO AMPLIFICATION SYSTEM. DESIGNED TO DRIVE A 4-OHM LOAD (EQUIVALENT TO A SINGLE 4-OHM SPEAKER OR TWO 8-OHM SPEAKERS IN PARALLEL). THIS CHIP CONTAINS THERMAL SHUTDOWN CIRCUITRY TO PROTECT ITSELF FROM EXCESSIVE LOADING. THIS WILL CAUSE SEVERE DISTORTION DURING OVERLOAD CONDITIONS. YOU MUST USE AN APPROPRIATE HEAT SINK (e.g. RADIO SHACK 276-1363). SPREAD SOME HEAT SINK COMPOUND (276-1372) ON THE LM383 TAB BEFORE ATTACHING THE HEAT SINK.

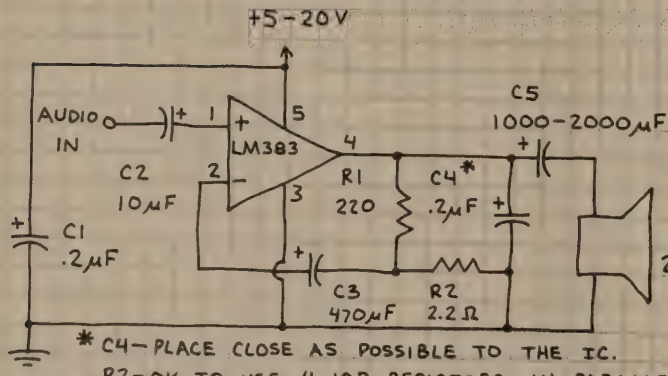


NOTE PRE-FORMED LEADS.



1 - + IN
2 - - IN
3 - GND
4 - OUT
5 - +5-20V

8-WATT AMPLIFIER

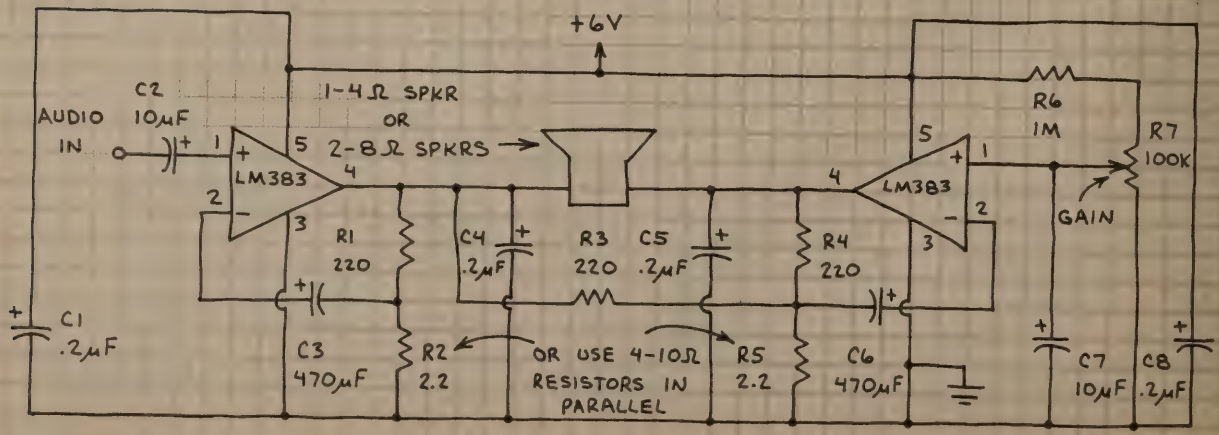


* C4 - PLACE CLOSE AS POSSIBLE TO THE IC.
R2 - OK TO USE 4-10Ω RESISTORS IN PARALLEL.

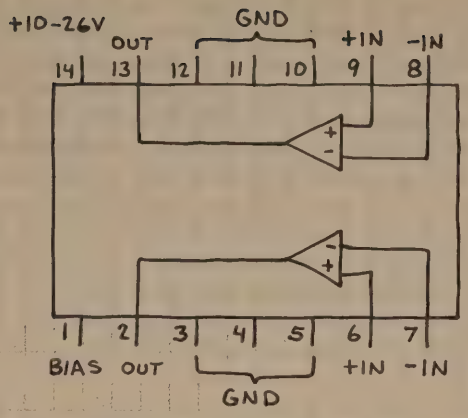
OPERATION:

1. USE HEAT SINK.
2. REDUCE POWER SUPPLY VOLTAGE TO 6-9 VOLTS (AS IN CIRCUIT BELOW) IF SEVERE DISTORTION OCCURS.
3. DON'T APPLY EXCESSIVE INPUT SIGNAL.

16-WATT BRIDGE AMPLIFIER



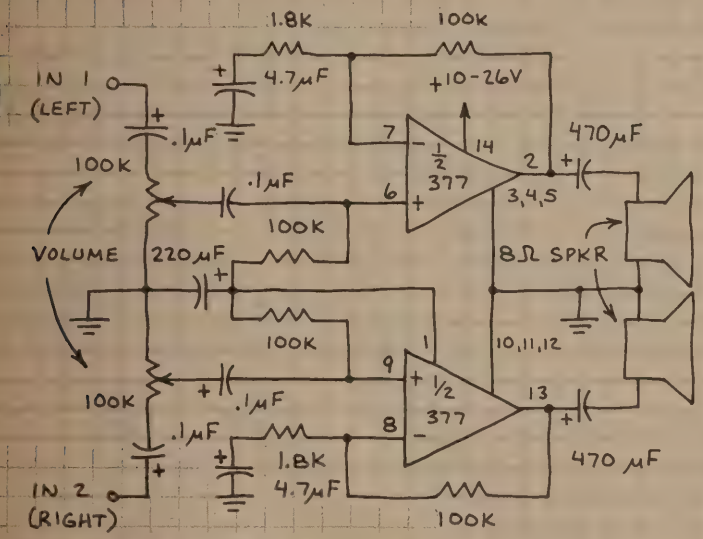
DUAL 2-WATT AMPLIFIER LM1877/LM377



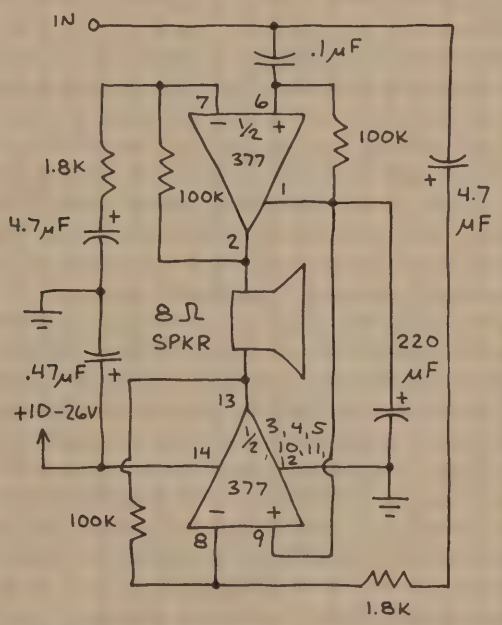
HIGH QUALITY, EASY TO USE POWER AMPLIFIER. IDEAL FOR DO-IT-YOURSELF STEREO, P.A. SYSTEMS, INTERCOMS, ETC. AUTOMATIC THERMAL SHUTDOWN PROTECTS AGAINST OVERHEATING. 70 dB CHANNEL SEPARATION MEANS VIRTUALLY NO CROSSTALK. ONLY 3 MICROVOLTS NOISE INPUT. HEATSINKING: UNNECESSARY IN MANY APPLICATIONS SINCE AVERAGE POWER IS USUALLY WELL BELOW BRIEF PEAKS. IN ANY CASE, PINS 3, 4, 5, 10, 11 AND 12 SHOULD BE CONNECTED TOGETHER. IF LOAD EXCEEDS DEVICE RATING, THERMAL SHUTDOWN WILL OCCUR.... AND WILL CAUSE SEVERE DISTORTION. USE HEATSINK (UP TO 10 SQUARE INCHES OF COPPER FOIL ON PC BOARD OR METAL FIN) IF THIS OCCURS.

NOTE: GND PINS SHOULD BE HEAT SUNK FOR MAXIMUM POWER.

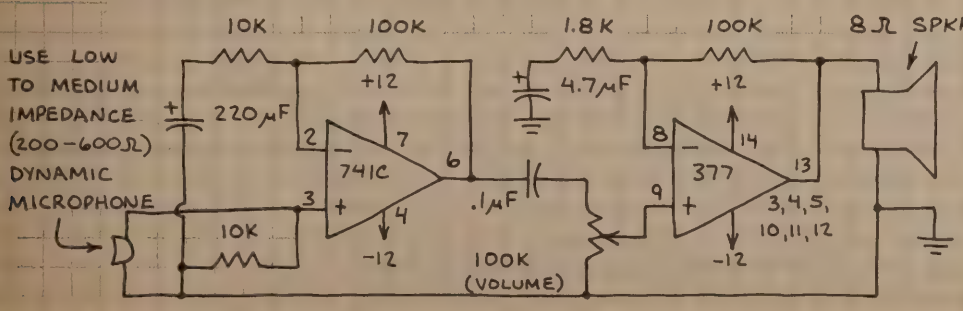
STEREO AMPLIFIER



4-WATT AMPLIFIER



PUBLIC ADDRESS SYSTEM



USE LOW TO MEDIUM IMPEDANCE (200-600Ω) DYNAMIC MICROPHONE

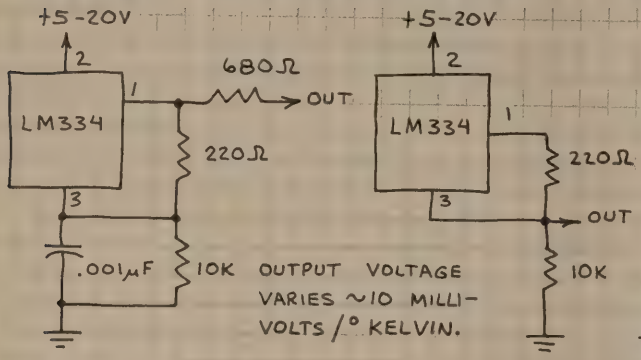
THIS CIRCUIT WORKS WELL. NOTE FEWER PARTS IN LM1877 / LM377 STAGE... THANKS TO SPLIT POWER SUPPLY.

TEMPERATURE SENSOR AND ADJUSTABLE CURRENT SOURCE LM334 (276-1734)

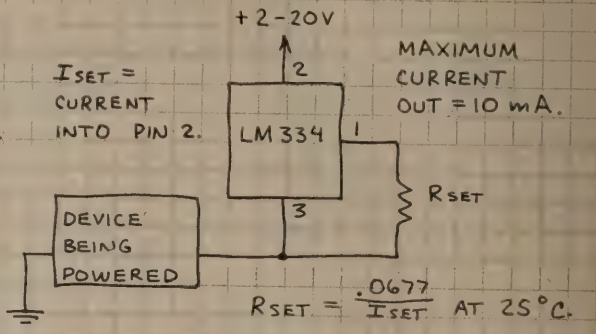
1 = R
2 = +V
3 = -V (GND)

VERSATILE 3-LEAD COMPONENT THAT LOOKS MORE LIKE A TRANSISTOR THAN AN IC. CAN BE USED AS A TEMPERATURE SENSOR, CURRENT SOURCE FOR LEDs AND OTHER COMPONENTS OR CIRCUITS, VOLTAGE REFERENCE, ETC.

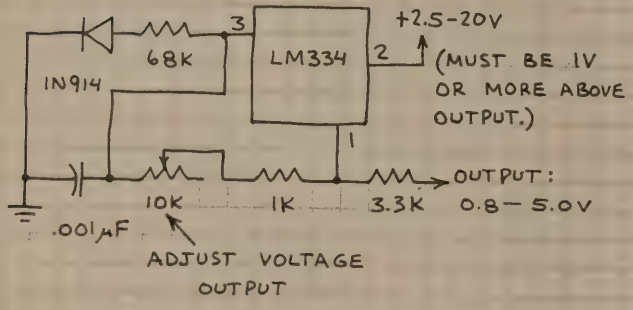
BASIC THERMOMETERS



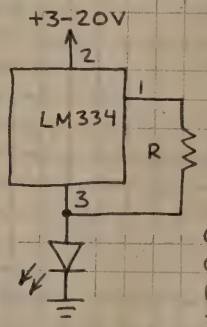
BASIC CURRENT SOURCE



VOLTAGE REFERENCE



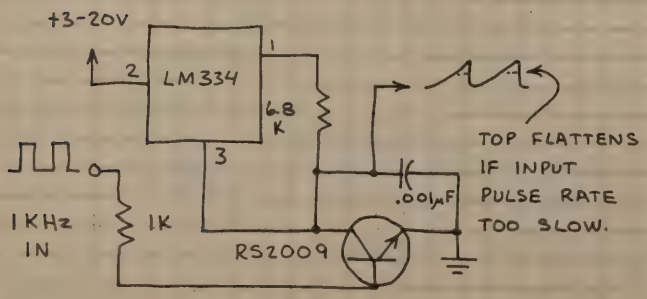
CALIBRATED LED



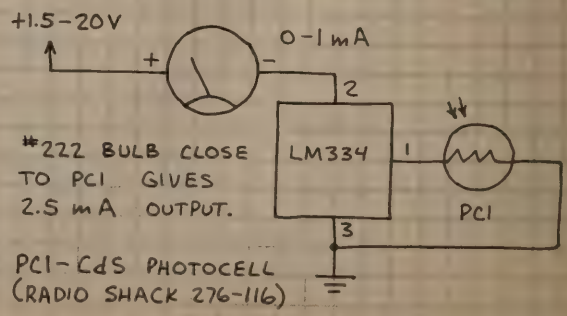
R	LED CURRENT
10 Ω	6.4 mA
15 Ω	4.3 mA

CONSTANT LED OUTPUT FOR ANY INPUT BETWEEN 3-20 VOLTS.

RAMP GENERATOR



LIGHT METER

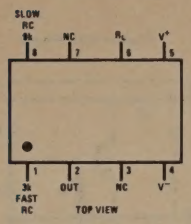


276-1705

LED FLASHER/OSCILLATOR

The RS3909 is a monolithic oscillator specifically designed to flash Light Emitting Diodes. By using the timing capacitor for voltage boost, it delivers pulses of 2 or more volts to the LED while operating on a supply of 1.5V or less. The circuit is inherently self-starting, and requires addition of only a battery and capacitor to function as a LED flasher.

Dual-In-Line Package



ARCHER
TECHNICAL DATA

AN EXCLUSIVE RADIO SHACK SERVICE TO THE EXPERIMENTER

absolute maximum ratings

Power Dissipation	500 mW
V^+ Voltage	6.4V
Operating Temperature Range	−25°C to +70°C

electrical characteristics

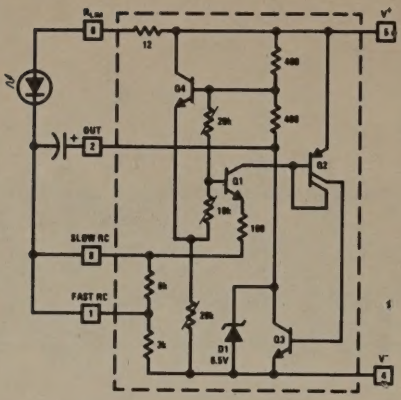
PARAMETER	CONDITIONS (Applications Note 3)	MIN	TYP	MAX	UNITS
Supply Voltage	(In Oscillation)	1.15		6.0	V
Operating Current			0.55	0.75	mA
Flash Frequency	300μF, 5% Capacitor	0.65	1.0	1.3	Hz
High Flash Frequency	0.30μF, 5% Capacitor		1.1		kHz
Compatible LED Forward Drop	1 mA Forward Current	1.35		2.1	V
Peak LED Current	350μF Capacitor		45		mA
Pulse Width	350μF Capacitors at 1/2 Amplitude		6.0		ms

Typical Operating Conditions

V^+	NOMINAL FLASH Hz	C_T	R_S	R_{FB}	V^+_{RANGE}
6V	2	400μF	1k	1.5k	5–25V
15V	2	180μF	3.9k	1k	13–50V
100V	1.7	180μF	43k 1W	1k	85–200V

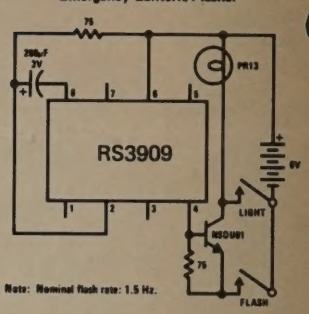
schematic diagram

Typical 1.5V Flasher



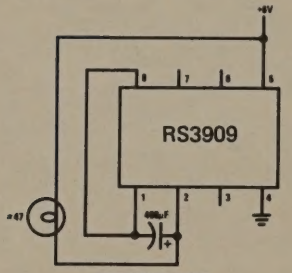
typical applications

Emergency Lantern/Flasher



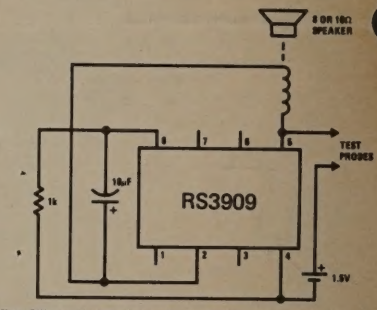
Note: Nominal flash rate: 1.5 Hz.

Incandescent Bulb Flasher



Note: Flash rate: 1.5 Hz.

"Buzz Box" Continuity and Coil Checker



Note: Differences between shorts, coils, and a few ohms of resistance can be heard.

APPLICATIONS NOTES

Note 1: All capacitors shown are electrolytic unless marked otherwise.

Note 2: Flash rates and frequencies assume a ±5% capacitor tolerance. Electrolytics may vary −20% to +100% of their stated value.

Note 3: Unless noted, measurements above are made with a 1.4V supply, a 25°C ambient temperature, and a LED with a forward drop of 1.5V to 1.7V at 1 mA forward current.

Note 4: Occasionally a flasher circuit will fail to oscillate due to a LED defect that may be missed because it only reduces light output 10% or so. Such LEDs can be identified by a large increase in conduction between 0.9V and 1.2V.

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